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PAUCITY OF SCIENTIFIC MAN-POWER IN COLONIAL RESEARCH

A DOMINANT note in last year's report on Colonial research is even more pronounced in the report "Colonial Research (1948–49)" discussed on p. 470 of this issue. In his speech in the House of Commons on July 20, Mr. Creech Jones directed attention to the dependence of Colonial development and welfare schemes upon the availability of technical staff rather than of financial resources. That main theme runs through almost all the reports that are presented under the title "Colonial Research", though with varying degrees of emphasis. A main preoccupation of the Colonial Social Science Research Council is, indeed, the problem of securing a sufficient number of suitably qualified research workers to make a reasonable impression on the formidable mass of research projects now listed for priority treatment. The brief note from the Colonial Economic Research Committee indicates that in its field the position is even worse, and the comprehensive programme of Colonial economic research at present being prepared is to be undertaken "as and when qualified research workers become available".

So far as social science is concerned, the position has been somewhat alleviated by fulfilment of the scheme for postgraduate research studentships, twelve of which have now been awarded. Three awards are for training for anthropological studies in East Africa and four for socio-economic surveys in West Africa. A scheme has also been approved by the Social Science Research Council for funds to enable a small number of American anthropologists and sociologists to pursue a six-month preliminary course of study at a university or similar institution in the United Kingdom preparatory to undertaking a research project, probably in Africa. Four studentships have so far been awarded, and this experimental scheme will be watched with interest by workers in other branches of science.

References to the staff position are less explicit in the report from the Colonial Medical Research Committee, apart from indications as to where developments are being delayed, as in the Research Laboratory at Freetown, Sierra Leone, in the African trials with B.C.G. vaccine in the prevention of tuberculosis, the Virus Institute in Nigeria, and research into hot-climate physiology, because of the absence of suitable staff. The Committee for Colonial Agricultural, Animal Health and Forestry Research, however, has found serious difficulty in recruiting fully qualified men for certain fields, particularly for soil surveys in tropical and sub-tropical areas and for research on stored products. Schemes for studentships for both these fields have been approved, and six studentships are to be offered in the first year and six in the second. The Colonial Insecticides Committee's report points out that immediate formation of a research unit in West Africa has been prevented by the difficulty of obtaining the scientific staff and by the grave shortage of trained scientific workers for insecticide research in the Colonies.

This Committee also has recommended the award of six studentships to young graduates for training in insecticides research in the United Kingdom, preparatory to employment with insecticide research teams in the Colonies. The Committee also has agreed to a request that two Beit scholarships which are being offered to Southern Rhodesians should carry as part of the training attachment to the Colonial Insecticides Research Unit in East Africa. Furthermore, following the approval by the Economic Recovery Administration of a project inviting American men of science, partly paid for from European Recovery Programme funds, to work with British research workers in Africa on schemes designed to increase the knowledge of, and to assist in the struggle against, trypanosomiasis, malaria and the insect-borne diseases of men, cattle and crops, an official request has been made for the assistance of American men of science to work on insecticide problems. The work of the Committee and the type of officer required has already been explained to the American liaison officer during his recent visit to Great Britain, and it is considered that such men of science could best be used by incorporating them in teams with British workers having a knowledge of local conditions.

Nor is this all. The Committee is also gravely concerned as to the lack of fundamental data for the proper use of insecticides and is anxious that Government research institutes, university departments and industrial laboratories should be encouraged to increase their research effort on the fundamental problems. Here again the general shortage of research staff will prevent rapid progress, while the Committee is also alive to the very real contribution which industry has to make towards the solution of the many problems of insect control. That contribution is probably best made less in the field of fundamental research than in those of field trials and development.

Moreover in this field, as in that which the Colonial Products Research Council surveys, the contribution of industry to research progress is affected by the general position of scientific staff. Production staff as well as research staff are drawn from the universities; and the Colonial industries, as the Council rightly notes, will naturally look to the newly established Colonial universities to provide them with their scientific staff. The Colonial Products Research Council regards it as one of its functions to assist these universities by the provision of maintenance grants for training research students, just as the Department of Scientific and Industrial Research does in Great Britain.

Other deficiencies in staff are noted in the report of the Colonial Research Council itself, which states that, because of the shortage of trained meteorologists, no Colonial Meteorological Service has been able to undertake any new research work. In the absence of a suitable candidate, no progress has been made with the West African Fisheries Research Institute. While neither the field survey nor the cartographic establishment of the Directorate of Colonial (Geodetic and Topographic) Surveys is yet up to full strength, recruitment and training have progressed steadily. On the other hand, in the Geological Survey only eighteen instead of the anticipated twenty-five new geologists were recruited during the year, and it is estimated that about a hundred geologists are now required, and that it will be impossible to fill all vacant posts from the United Kingdom and other Commonwealth sources until 1952. The annual requirement of geologists for the Colonial Geological Surveys thereafter is estimated tentatively as twelve.

This is the only passage in the report where an attempt is made to assess quantitatively the requirements of the Colonial services in terms of scientific man-power; and when that has been done the collective and analysed total has to be set against other requirements in the United Kingdom and Commonwealth countries, as well as against the anticipated output of men of science which the expansion of the British and Colonial universities will provide. That is a matter which requires close consideration not only by the universities themselves and the Ministry of Labour's Technical Personnel Committee, of which Lord Hankey is chairman, but also at a higher level, possibly by the Advisory Council on Scientific Policy.

While the Colonial Secretary himself appears to be fully aware of the importance of this question of scientific and technical staff and to recognize its implications, neither he himself, nor other speakers in the two most recent debates in the House of Commons touching on Colonial affairs, that on the East African Groundnuts Scheme on July 27 and that on Africa on July 29, gave any positive indications as to how the situation was to be improved. Mr. Creech Jones showed that he had an open mind on the question of conditions of service, and that he was reviewing the possibility of a scheme for earlier retirement. The effort to improve generally the conditions of employment of the technical and administrative staff of the Colonial service, while welcome, is none the less more in the way of removal of obstacles to recruitment than the positive action also required at the moment.

Nevertheless, it must be recognized that the Select Committee on Estimates in its critical report last autumn advanced very little in the way of positive suggestions. The revised scheme of Colonial Research Fellowships to operate during the years 1949–53, details of which are appended to the Council's report, may well prove a much more important contribution to the encouragement of scientific research on Colonial problems, particularly when supported by the schemes for preliminary training of postgraduate students already noted. The offer of the Economic Co-operative Administration set up under the Marshall Aid scheme to try to provide twenty-two geologists and three chemists to assist the Geological Survey staff during the coming three years should be considered against these attempts to deal with the long-term situation. The Colonial Research Council is also hoping to recruit well-qualified geologists by three-year contracts from various European countries.

It was stated by the Under-Secretary of State for Colonial Affairs, Mr. D. R. Rees-Williams, on July 27 that recruitment of twenty-eight American geologists

and associated men of science to the Colonial Geological Survey Service to facilitate completion of the basic mining survey by 1956, as indicated in the recent report, "The Colonial Territories (1948–1949)", was expected to begin in the near future. Preliminary proposals from the United States authorities had already been forwarded to the Colonies for their approval. On July 28 the Minister of Education, in reply to a question as to the supply of technologists, stated that he thought that existing arrangements in Great Britain were capable of meeting reasonable demands; but that he was keeping in mind the importance of the American offer of co-operation in Colonial development. On the same day the Financial Secretary to the Treasury stated that the pre-war numbers of university students in science and technology were nearly doubled by 1947–48 and had continued to rise. Arrangements had just been concluded, he said, for sending fifty British men of science and technicians to the United States with the assistance of the Economic Co-operation Administration for two years of graduate study. Both questions and answers indicate that the Government and Parliament are alive to the importance of President Truman's offer to assist in Colonial development throughout the world, and the part which men of science have to play in such development. On the following day the Parliamentary and Scientific Committee submitted to the Prime Minister an interim report on the implementation of this Fourth Point, while President Truman has himself recently made clearer to Congress the significance of his programme for technical assistance to the under-developed areas. In that message to Congress he stressed particularly the need for scientific and technical knowledge to prepare the way for productive investment and to create conditions in which capital investment could be fruitful.

The report from the Parliamentary and Scientific Committee urges that special efforts should be made to ensure at the earliest opportunity the fullest Anglo-American co-operation in implementing the Fourth Point. The Committee recommends first that conversations should be initiated with the Government of the United States to ascertain how British science and technology can collaborate to the fullest possible extent in the world-wide campaign involved, and to consider the best means by which American technology and capital can be enabled to assist our plans for improving the conditions of under-developed areas within British Colonial territory. The Committee emphasizes the importance of such general complementary facts as proper planning, research, surveys, native education, the study of population and racial problems, as well as of sociological and political requirements in the territories concerned, if collaboration is to be effective; and it also stresses the necessity of attracting and training competent men of science and technologists for the tasks involved.

On this point, while recognizing that the scarcity of men of science and technologists is more acute in Britain than in America, the Committee asks the question why this country is not capable of furnishing the men required, and it may be anticipated that the final report from the sub-committee which prepared this report will go much more closely into the question and will not be content to find an explanation solely in the terms of service not being sufficiently attractive. Meanwhile the sub-committee recommends that we ensure an increased supply of technologists by embarking on the necessary training schemes in Great Britain. It suggests that the supply of technologists could be one of our main contributions to the Fourth Point programmes if plans were made now for their training and subsequent careers.

This report has been prepared with the last available report on Colonial research before the sub-committee, and a review of the research projects listed in that report so as to ascertain which could most rapidly be helped forward by aid under the Fourth Point is recommended. A separate review is recommended to see which projects are most likely to be of interest to other countries and could be offered as a contribution to the general aid programme. A similar study of American scientific developments as revealed in the annual report of the Interdepartmental Committee on Scientific and Cultural Co-operation is also recommended, but besides this the sub-committee gives its own list of scientific and technological projects which could well benefit immediately from Fourth Point aid. Besides geological survey and schemes for eradicating tsetse, these include the production of animal fodder in the Middle East, development of irrigation and drainage schemes, medical research designed to encourage European immigration to tropical or sub-tropical territories, surveys of crops and of disease vectors and the utilization of tropical timbers.

If, therefore, trained scientific and technical man-power is the key to the development of the backward areas, whether in British or in other Colonial territories, there is both a short-term and a long-term problem. To the former the contribution of American men of science and technologists is an invaluable and, indeed, an essential aid; but in any expansion or development of technological or university education in these countries to meet the immediate situation, the short-term and the long-term problems must be recognized. In the long run the Colonial territories must be developed largely by their own people—men of science, technologists, medical men, lawyers, teachers and administrators—and, apart from the immediate assistance required from British men of science, technologists, and other professional workers, in solving urgent problems, the main problem is the disposition of, and resources of, trained man-power so as best to assist the Colonial peoples to train their own qualified workers. This is clearly recognized in the recent report on the Colonial territories, which notes that expansion in technical education in those territories in 1948–49, within the limits imposed by financial considerations and the continued need for more trained staff, has been satisfactory. This report, however, contains the reminder that the contribution of the British universities and technical colleges to the trained man-power and woman-power required for Colonial development is not to be considered in terms of British graduates only. Colonial students

in Great Britain and Eire at universities and technical colleges and on courses of instruction now number more than 3,400, and there are eleven liaison officers at the Colonial Office looking after their interests.

With the growth of the Colonial universities the numerical importance of this contribution from Britain may decrease, though it will never disappear, and much will always depend on such interchange. Indeed, as the numbers of Colonial students decrease it will become even more essential that they should not be segregated in hostels but brought within the constructive influences of Great Britain. The Government's plans in this connexion, to which Mr. Creech Jones referred on July 29, are no temporary measure, but are of permanent and far-reaching value in promoting the understanding and goodwill upon which effective co-operation is based. The needs of the Colonial territories have, indeed, to be kept constantly in mind in considering the expansion of university and technological education in Great Britain, and adequate provision must be made to meet both the immediate and long-term needs. But the supreme consideration is not numbers but quality, and even the finest training will not bear its full fruit unless the student receives with it some understanding of the finest elements in Western civilization. This is most often and most freely acquired, not in lecture room or laboratory, but in the intimate discussions of common rooms or the private studies of our residential universities at their best, and still more in the intimacy of those cultured homes which are opened to the overseas student by men and women of wide sympathy, understanding and vision.

ECONOMICS—SCIENTIFIC AND OTHERWISE

Economics for Everyman

By Arthur Coe. Pp. xii+275. (London : Chapman and Hall, Ltd., 1948.) 15*s*. net.

Economic Wellbeing

By C. B. Purdom. Pp. 222. (London : Ivor Nicholson and Watson, Ltd., 1948.) 8*s*. 6*d*. net.

Fundamentals of Economics

By Dr. Myron H. Umbreit, Elgin F. Hunt and Dr. Charles V. Kinter. Pp. xi+461. (New York and London : McGraw-Hill Book Co., Inc., 1948.) 22*s*. 6*d*.

Economics

An Introductory Analysis. By Prof. Paul A. Samuelson. Pp. xx+622. (New York and London : McGraw-Hill Book Co., Inc., 1948.) 27*s*.

Economic Man in Relation to his Natural Environment

By C. Reinold Noyes. Vol. 1. Pp. xiv+692. Vol. 2. Pp. ix+693–1443. (New York : Columbia University Press ; London : Oxford University Press, 1948.) 82*s*. 6*d*. net.

THESE books constitute a not unrepresentative sample of what is constantly being published under the head of 'Economics'—a heading which covers both genuinely scientific works and crude polemics. "Economics for Everyman" and "Economic Wellbeing" are of the latter kind, and are easily disposed of. Mr. Purdom's book is a blueprint for a system of national economic planning constructed in happy innocence of both the political and the economic problems involved. Mr. Coe has erected a Utopia on the basis of the writings of John Ruskin, with a moral earnestness which, alas, is no substitute for sound analysis, and which cannot preserve him from a fundamental fallacy about the nature and functions of money.

"Fundamentals of Economics" and "Economics : An Introductory Analysis" are works of a very different kind ; both are text-books for students, written by American professional economists. There, however, the resemblance between them almost ends, since they illustrate in a very interesting way the commonest two current approaches to the teaching of economics. Messrs. Umbreit, Hunt and Kinter follow, in the main, the older tradition. They start with an analysis of the nature of production and proceed through an account of the monetary system, which makes the division of labour possible, to the account of the pricing and distributive systems which occupies the main part of the book. The emphasis throughout is largely a 'business' emphasis, and private enterprise occupies the centre (indeed, for most of the book, the whole) of the stage. The presentation, too, is somewhat conservative ; the developments of the last fifteen years in economic theory have made only a superficial impression on it ; Keynes's theory of employment is summarized only in a footnote on p. 108, with the warning that it is "still highly controversial" ; and the references for further reading are very largely to other text-books rather than to works embodying research.

Prof. Samuelson, on the other hand, adopts something like the method of exposition made popular in Great Britain some years ago by J. R. Hicks in his "Social Framework"—he proceeds (after an introductory account of the basic economic problems of any society) to describe the nature, the actual distribution, and the fluctuations of the national income before going on to discuss the theoretical principles by which economists seek to account for its level, its changes and its composition. The emphasis throughout is largely on broad social factors and consequences. In short, Prof. Samuelson who, like Mr. Hicks, is one of the most brilliant mathematical economic theorists of his generation, adopts for his students an approach which is far more empirical and far less deductive than the older one. The latter approach, with the emphasis on the theory of value and on the presumed behaviour of business men, assumed that the main task of economics was to explain and interrelate the almost universally known facts of economic life, which meant, largely, the facts relating to private business and private consumption. The newer approach puts far more emphasis on the discovery and exposition (mainly statistical) of the economic facts about society as a whole, and approaches the task of explaining or interrelating them with something more of scientific humility. It constitutes, in fact, a step towards presenting economics as an empirical science.

Mr. Noyes's massive book constitutes a different kind of search for a sounder basis for economic theory. It embodies seventeen years of work in the biological sciences to bring together the knowledge relevant to human behaviour, and to relate it to the fundamental assumptions of economic theory. The result is certainly most impressive and interesting—

far more, however, for its own sake than for any contribution which it can make to economics. For the fact is that economists have been coming to realize in recent years that their subject does not really rest on eighteenth-century psychological assumptions concerning the rationality of human conduct. The theoretical apparatus of indifference curves is merely a description of the factual pattern of human choice, which can be given useful content only by statistical investigation of the behaviour of considerable numbers of people over considerable periods of time. Mr. Noyes's contention that wants are satisfied completely and successively rather than up to the economists' "point of equi-marginal satisfaction" is doubtless correct of the minute-to-minute or hour-to-hour behaviour of individuals; it does not, however, necessarily conflict even with the economists' conventional picture of the principles according to which people budget for their wants over the week or the year—still less does it interfere with the statistically valid demand functions which have been established for communities, relating quantities of goods bought to incomes and relative prices in a way which is largely consistent with the conventional picture of the individual's indifference-map. If one takes the modern view that economics is founded on the study of behaviour, then the ultimate court of appeal for or against an economist's generalizations lies in social or market statistics. It is to these statistics, not to utility theory (on which the main body of economic theory no longer depends), that the physiological accounts of human behaviour must, in the end, be related.

There is, however, a very great deal in Mr. Noyes's book which the economist will find important. His approach towards the rehabilitation of 'embodied' real cost, for example, is very interesting. On the other hand, there is much (perhaps most notably the sections in the Appendix C on micturition and defæcation) which most economists would regard as lying outside their professional field. A. J. Brown

OBSTETRIC AND GYNÆCOLOGICAL ATLAS

Atlas of Mahfouz's Obstetric and Gynæcological Museum

By Prof. Naguib Pacha Mahfouz. Vol. 1. Pp. xviii+418. (Altrincham: John Sherratt and Son, 1949.) 3 vols., £9 9*s*. 0*d*. net.

THIS first volume is by one of the greatest exponents of the art of obstetrics and gynæcology and is the most valuable contribution yet published on the subject. Mahfouz has a world-wide reputation for his work and for his great surgical skill. The illustrations in colour and in black-and-white are reproduced from the author's museum specimens, who personally supervised in their preparation. The text is in English; but explanatory notes of the illustrations are in seven languages.

The clinical features and operative procedures are conveyed in the text. When describing abnormal conditions of the placenta, stress is laid upon the dangers of attempts at digital removal of placenta accreta, which is of rare occurrence but is a cause of post-partum hæmorrhage.

A series of plates illustrates the position of the fœtus in post-mortem specimens of the uterus. The description of rupture of the uterus is comprehensive, and in itself is a unique contribution to the literature of this subject.

The author discusses the causes of antepartum hæmorrhage due to placenta prævia and toxæmia. The former is rare in primigravida, and occurs most frequently in multiparæ where the pregnancies have followed one another in quick succession. The chief factor in the maternal mortality is due to shock—60 per cent. Sepsis accounts for 38 per cent and post-partum hæmorrhage for 2 per cent.

Facts are clearly stated without many theories as to cause and effect. This in itself is a great advantage from a teacher's and a student's point of view.

This volume is also of inestimable value to the pathologist, and references to the signs of virginity and hermaphrodism are useful in medico-legal discussions. No teacher should be without this publication, and we await with great interest the issue of the completed Volumes 2 and 3.

Naguib Pacha Mahfouz is to be warmly congratulated on the production of a magnificent piece of work, the result of years of research and clinical experience. A. Louise McIlroy

SEX RELATIONSHIPS, THE FAMILY AND SOCIETY

Social Biology and Welfare

By Sybil Neville-Rolfe. Chapter 8 contributed by A. E. W. McLachlan, together with a Handbook-Appendix on Social Problems, edited by Ethel Grant. Pp. 416. (London: George Allen and Unwin, Ltd., 1949.) 21*s*. net.

IN 1905, at the age of twenty, the widow of a naval officer announced to her relatives her intention "to study prostitution and venereal disease and try to get rid of them". She knew of no organisation or senior friend under whose tutelage she could begin. With courage and energy, Mrs. Neville-Rolfe plunged into the obscurity and obscurantism surrounding the problems of sex irregularity; learning the hard way, but backed by the irrepressible gifts of her personality, she has given the last forty-five years to by no means unsuccessful efforts to induce the public and officials, both at home and abroad, to face squarely and openly some of the biological and social factors involved in healthy and unhealthy sex and family relationships in the community.

She describes her book as "an effort to crystallize the experience of some forty years" in this field. Unfortunately, the book itself is not a useful contribution to the campaign for a rational, humane and continuously constructive approach to the problems of social hygiene, the complexities of which grow the more we know about the field. The author is right to stress the fact that the solidarity of the family structure is much more significant than its sporadic partial incoherence. But much of her material is naïve and its presentation difficult. The lucid chapter on venereal diseases by Dr. McLachlan and the three chapters on prostitution by Mrs. Neville-Rolfe overweight the book against the interest of the general reader, for whom presumably it is designed. It is hard to grasp what Mrs. Neville-Rolfe is getting at for much of the time, and perplexity is increased by astonishing inaccuracies, as, for example, the statements that Mr. Balfour was Prime Minister in 1912, that in 1946 there were 400,000 pensionable old persons in England

and Wales, or that the Bretton Woods conference was about nutrition. Twice the author enjoys herself in vigorous passages exposing the dangers inherent in a Civil Service composed of an intellectual *élite* the members of which are so imbued with loyalty and integrity in relation to a system, which, in return, gives them security, that they neglect the moral and intellectual obligation to follow the truth wherever it leads.

To write a sustained work relating three such ill-defined but important subjects as social biology, social welfare and social philosophy needs a remarkably well-ordered mind and exceptional literary skill. Mrs. Neville-Rolfe's gifts are more those of a crusader than of a writer; her enthusiasm and courage have played an influential part in freeing consideration of sex relationships in their social aspect from the taboos which hindered either biological or social scientists from tackling the subject so recently as forty years ago. The weakness of her book does not diminish the debt owed to her and her like by the inquiring scientific mind. ROGER WILSON

THE BRITISH WILD FLORA

Introduction to Wildflowers

By Richard Morse. Pp. 266+48 plates. (London: Adam and Charles Black, Ltd., 1949.) 12*s*. 6*d*. net.

RICHARD MORSE'S latest book is described as "a simple, readable introduction to the study of British wildflowers". This unpretentious claim is justified by the book itself, which, in clear and non-technical language, shows how flowers may be identified, how they live, behave and reproduce. The book is arranged in two parts. Part 1 contains an account of some of the more interesting families of British wildflowers, which are always referred to by their common names, botanical names being omitted. This half of the book has been deliberately planned to draw the new reader on and on without upsetting his supposed dislike for technical terms. Part 2 has been written to supplement Part 1 and contains a short synopsis of all the families of British flowering plants, Latin names being included. It also contains sections giving the numerical distribution of wildflowers, their usual habitats and the seasons at which they appear as well as a section in which wild flowers are arranged according to their colour. A well-arranged bibliography is included as a valuable appendix, and there are also four indexes giving English and Latin names to individual flowers and to the families to which they belong, with the necessary cross-references.

At first sight the arrangement of this book is confusing; but closer acquaintance shows that, for the elementary reader he has in mind, Morse has produced a book which should achieve his purpose. For the reader with a little knowledge of wild flowers and no particular dread of Latin names—many authors of wide experience believe that these, in fact, attract the inquiring beginner much more than they repel—the frequent journeys to the rear of the book for further information may be somewhat irritating and scarcely necessary.

The outstanding feature of the illustrations are the thirty-two photographs, some of which are of unusual quality as black-and-white reproductions. The line-drawings are clear, and there are sixteen colour plates. T. H. H.

DEVELOPMENT OF SOCIOLOGY

Societal Evolution

A Study of the Evolutionary Basis of the Science of Society. By Prof. Arthur Galloway Keller. Revised edition. Pp. ix+419. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1947.) 21*s*. net.

An Introduction to the History of Sociology

Edited by Harry Elmer Barnes. Pp. xvi+960. (Chicago: University of Chicago Press; London: Cambridge University Press, 1948.) 55*s*. net.

AMERICAN sociology has now a long and honourable history behind it; the vitality which it shows at the present time is in large measure due to the soundness of the foundations that have been laid during the past half-century. The time has, indeed, now arrived when some of the outstanding classic works should be re-published, and for a general appraisal to be made of the work that has been achieved by the earlier pioneers.

A good example of a work that has been too easily overlooked in Great Britain is Prof. A. G. Keller's "Societal Evolution". This was originally produced in 1915; in the edition of 1931 which is now reprinted, it is both a memento of a young and vigorous period in the development of American sociology, and also a demonstration of the way in which Summer's approach to the problem of social change was extended by Prof. Keller, his disciple and successor at Yale. The ideas embodied in it may perhaps strike the younger sociologist of to-day as somewhat naïve; for the evolutionary theories of both Spencer and Summer have been rejected as, at best, a gross over-simplification of the problem. Nevertheless, the content of the subject of sociology has been largely determined by the range of interests of the classic authors, particularly by their exploitation of the rich territory of ethnology, and it has been shown to be possible to separate the 'automatic' theory of social evolution from the evidence which was adduced in support of these views. The work of Summer's school, therefore, still endures in part, and the present generation of sociologists would do well to treat what is perhaps "the most forceful American statement of the evolutionary basis of individualism and laissez-faire" with due respect.

The above quotation is from "An Introduction to the History of Sociology", edited by Harry Elmer Barnes. This is an exceedingly useful work of reference; but it is no mere collection of 'points of view' or 'contributions' by various authors and schools of thought. As the editor points out, it is high time that an appraisal should be attempted of the various 'systems' of sociology which have appeared from the time of Comte to the present day, for systematization is now being gradually but completely "replaced by specialization in some more restricted field of description and analysis"; in brief, "the era of systematic sociology has come approximately to an end".

Whether or not this will involve a retreat to an 'ivory tower', built on new lines, time alone will show. If, however, sociology is successfully developed as a tool to serve man's needs rather than as an elegant but useless subject of study, it will only be because our critical powers have been fully employed in the task. Mr. Barnes's penetrating survey of the past is therefore a most useful aid to the shaping of a new science on 'operational' rather than 'philosophical' lines.

Inorganic Chemistry

By Fritz Ephraim. Fifth edition, revised, by Dr. P. C. L. Thorne and Dr. E. R. Roberts. Pp. xii+940. (London and Edinburgh: Gurney and Jackson, 1948.) 32*s.* net.

THE general plan and contents of this book are now well known, so that it will be sufficient to recall that it aims at presenting the facts of inorganic chemistry in a generalized form which shall at the same time be readable and interesting. This aim is successfully achieved. The book is suitable only for advanced students; but for all students who have had systematic courses in inorganic chemistry it provides material for revision and extension of existing knowledge which cannot fail to be valuable and attractive. It contains sections on atomic structure and valency, and the part dealing with co-ordination compounds is unusually good. The revision of the book has been very well done, much new material not in earlier editions having been added. Much of the vague and often incorrect material present in the German edition has been eliminated, and the English editors must alone take the credit for much that is good in the book.

Several inaccuracies in the last edition, which were pointed out in a review in the *Journal of Physical Chemistry*, are still present. Since these were given before, it will be sufficient to point out that the oxide OF still appears, that the apparently ineradicable melting point −76° for chlorine dioxide is given a new lease of life, and that, although fewer names are mis-spelled than formerly, "Losenty" still does duty for "Lorentz". One misstatement should certainly be corrected. Although it is said (p. 580) that Wöhler and Wegwitz found sulphur monoxide as a decomposition product of S_2O_3, while Vogel and Partington failed to obtain it, the real fact is that no one has ever detected it, the German authors merely inferring its formation as an intermediate stage and stating that they were unable to detect its presence at any time. Some inaccuracies are certain to be found in such a large book; but it may reasonably be expected that they should be corrected when they are pointed out. The speculative formulæ for the higher carbonyls (p. 807) could be omitted in a future edition. The book is one which can be warmly recommended, and its continued success is fully justified by its contents. J. R. P.

Non-Ferrous Production Metallurgy

By John L. Bray. Second edition. Pp. xiv+587. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 36*s.* net.

THE appearance, after a lapse of seven years, of a new edition of Bray's well-known book will be welcomed by all students and teachers of metallurgy needing some general guidance as to modern trends in process metallurgy. The depletion of high-grade ores, coupled with the demand for purer metals, necessitates more and more attention being given to the reduction and refining of available non-ferrous ores.

The present volume, excellently printed, includes accounts of new processes resulting from scientific developments during the Second World War, particularly in the extraction of aluminium, magnesium, nickel and tin. As might be anticipated, there is a bias towards the description of practice on the American Continent and, more particularly, of operations carried out in the United States. There are chapters dealing with general subjects such as ores; smelting, slags and fluxes; secondary metals; marketing of bullion, ores and concentrates; and the use of physical chemistry in metallurgical processes. The last-named chapter is an innovation and, although sound in principle, is far too compressed to be of any real value to the ordinary student.

The bulk of the text consists of twenty-three chapters devoted in turn to the individual metals, conveniently arranged in alphabetical order. Emphasis is laid on the chemistry of each process, while operating details have been greatly condensed. To facilitate reference, chemical equations relating to any one metal are numbered consecutively. Each chapter includes notes on the economics and statistics of the particular metal, and concludes with a generous list of references. The illustrations generally are clear, simple line drawings, excellent for their purpose. In one or two cases only have reproductions of rather complex flow sheets been so reduced in size as to become rather severe tests of eyesight.

This volume contains, in highly compressed form, a wealth of up-to-date information, compiled by an author who has obviously a first-hand knowledge of his subject. F. ORME

Handbooks for the Identification of British Insects

Vol. 1. Part 5. Dermaptera and Orthoptera. By W. D. Hincks. Pp. 20. 3*s.* 6*d.* net. Vol. 1. Part 10. Odonata. By Lieut.-Colonel F. C. Fraser. Pp. 48. 7*s.* 6*d.* net. Vol. 9. Part 1. Diptera. I. Introduction and Key to Families. By H. Oldroyd. Pp. 49. 7*s.* 6*d.* net. (London: Royal Entomological Society of London, 41 Queen's Gate, S.W.7.)

THE amateur student and collector of insects in the British Isles has been tolerably well provided with text-books which would enable him to identify his captures so long as he confined his attention to such well-worked groups as the Lepidoptera and Coleoptera. Once he ventured outside these narrow limits the identification of species presented such difficulties that he was discouraged. A vicious circle was thus set up: those groups in greatest need of study claimed the fewest students. It is the aim of the Royal Entomological Society of London to rectify this state of affairs by publishing a series of "Handbooks for the Identification of British Insects", written by specialists or groups of specialists, in which "conciseness and cheapness would be the main objectives", and which would provide illustrated keys to all the British species. The parts will be issued, separately paged and priced, as they become available. They will be paper covered, so that they may ultimately be bound in ten volumes.

Three parts have now appeared: Dermaptera and Orthoptera, by W. D. Hincks; Odonata, by Lieut.-Colonel F. C. Fraser; and the introductory volume on the Diptera, by H. Oldroyd. They constitute a most auspicious beginning. All these parts are clearly and concisely written, finely illustrated by copious line drawings, and, following a general account of the structure and early stages of each group, they are furnished with authoritative keys—extending to species in the Dermaptera, Orthoptera and Odonata, to families in the introductory volume on the Diptera. These are the kind of books which cannot fail to encourage students to take up the lesser known groups. They are an excellent beginning. The testing time will come in the parts which carry the identification of Diptera and Hymenoptera, for example, to the species level.

EXPLORING THE BED OF THE OCEAN*

By Prof. Hans PETTERSSON
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THE earth has, for very good reasons, been called the water planet. About 140 million square miles, or more than 70 per cent of the globe, are covered with water, and more than 90 million square miles of water has a depth exceeding 2,000 fathoms. No part of the earth's solid crust is less accessible to scientific investigations than the floor of the ocean. No part, on the other hand, offers a greater variety of unsolved problems. In our days, when both the north and the south poles have been reached, the deserts of central Asia, the primeval forests of Africa and of South America, and the barren ice-fields of Greenland and the antarctic continent have been explored, the last remaining white area on the world map is the ocean floor.

Over its abyssal area, an incessant although very slow fall of minute particles settles from the sea surface. There are remnants of plankton organisms, windblown dust from the great deserts, occasionally mingled with fine volcanic ash from great eruptions and, added to these, as very rare components, are tiny pellets of meteoritic iron scattered from the incandescent surface of shooting stars. In this manner the deep-sea deposits are built up through millions or hundreds of millions of years. They represent an unrivalled archive of the past history of our planet. Probing into them by means of tubular corers, sediment columns can be raised which contain the records from tectonic, volcanic, and climatic catastrophes of a remote past. On the other hand, the great ocean depths are not the lifeless 'azoic' region which they were supposed to be only a century ago. They are, in fact, inhabited by an abyssal fauna of fantastic creatures, capable of sustaining the terrific water pressure and the ice-cold temperature prevailing in great depths, without the faintest glimmer of daylight reaching down into the eternal night.

To science this fascinating field of study was thrown open by the famous *Challenger* Expedition of 1872–76, which marked the birth of deep-sea oceanography. During the three-quarters of a century which has passed since that pioneer cruise, immense progress has been made as regards instruments and methods used in marine research. In one particular respect, however, advance has been very slow, namely, in the technique of raising long and undisturbed cores from great depths. During the Second World War, Swedish oceanographers devoted a large part of their efforts to this problem. In 1942, by means of the vacuum core-sampler, constructed by Dr. B. Kullenberg and me, an undisturbed core, 45 ft. long, was raised from the depth of the Gullmar Fiord. Three years later the still more efficient piston core-sampler, invented by Kullenberg, brought up a core nearly 70 ft. long. Another advance, for which credit is due to Prof. W. Weibull, of the Bofors Armament Works, was the development of a method for sounding the thickness of the carpet of sediment over the ocean floor by recording echoes from exploding depth charges, which are reflected, not only against the bottom but also against the 'bottom below the bottom', affording a measure of a hitherto quite unknown quantity.

* Evening Discourse delivered on September 2 at the Newcastle upon Tyne meeting of the British Association.

After the new methods had been successfully tested in considerable depths during a preliminary cruise to the western Mediterranean in 1946, we felt encouraged to start in the following year the first Swedish Deep-Sea Expedition, sponsored by the Royal Society of Göteborg. The expedition ship, the 1,450-ton motor schooner *Albatross*, the new training ship of the Broström Shipping Combine of Göteborg, was lent to us for the purpose, on very generous conditions. The costs of the expedition were defrayed by donations from leaders of Swedish shipping and commerce, mostly citizens of Göteborg. Before the start on July 4, 1947, the *Albatross* was converted into a floating laboratory with accommodation for a scientific staff of ten to twelve, in air-conditioned cabins and laboratories. With our very heavy gear, including core-samplers weighing up to 1½ tons, carried by steel cables 4,400 fathoms in length and worked from a 140-kilowatt electric deep-sea winch specially constructed for rapid work, it was found advisable to lay our circumnavigating course within or near the fair-weather region of the equatorial calms. Fortunately, we here also encountered problems of special interest, both as regards the deep-sea deposits and the water masses above them.

I think I may summarize the results gained from this cruise of fifteen months duration as, in the main, satisfactory. We brought back a continuous record of the bottom profile along some 20,000 nautical miles of our course, registered by an excellent ultrasonic echograph specially constructed for the expedition by the Marine Instruments Co., of London. This echograph proved extremely valuable for our work in great depths both with the coring tubes and later in our deep-sea trawlings. We further brought back, carefully packed and in cold storage, two hundred long cores taken from depths between 2,000 and more than 4,000 fathoms, the integral core-length exceeding one statute mile. We also had more than four hundred oscillograms from explosions in depths between 300 and 3,500 fathoms and their echoes, and some four thousand samples of sea water from varying depths, some of them of large volume, for uranium- and radium-analyses. Ten thousand temperature records by reversing thermometers or, in the surface layers, by bathythermographs, are included in the oceanographical data, which were mainly concentrated along cross-sections through the equatorial current system. Observations were also made on submarine daylight in different spectral regions, including the ultra-violet, and on the occurrence of light-scattering particles suspended in the deeper water layers. Special attention was given to the very lowest water layers down to about two fathoms from the bottom.

All this material is now being worked upon in different laboratories, both in Sweden and abroad, by specialists in physics, chemistry, mineralogy, radioactivity, biology, etc. It will be several years before all our samples have been analysed and the results made ready for publication. At this stage of our investigations I can only give a brief report on results so far obtained.

Echograms. These display a surprising unevenness of the bottom profile, also in great depths. Sometimes

it rises or falls by distinct 'steps', from half a nautical mile to several miles in width, with heights varying between tens and hundreds of fathoms, suggesting 'faults' we must have crossed more or less transversely. In other instances, the bottom appears to be strewn with small hills or hummocks, giving two or more intersecting curves. A perfectly level bottom is an exception rather than the rule, a fact which proved a serious complication, both for coring operations and in our sediment measurements, as well as later in deep-sea trawling.

Explosion echoes. These echoes from the 'bottom below the bottom' surprised us by giving considerably greater values for the apparent thickness of the carpet of sediment in the Atlantic Ocean than in the Pacific and Indian Oceans, up to nearly 12,000 ft. and less than 1,000 ft., respectively. A possible explanation of the lower values may be the occurrence of intermediate lava beds, due to submarine eruptions, intercepting or reflecting the explosion waves. That such lava beds actually exist was proved by the coring work, for repeatedly a coring tube was stopped or damaged by hitting 'hard bottom' beneath a more or less superficial 'veneer' of recent sediments. In some cases broken-off fragments found in the bit of the corer showed beyond any doubt that the obstacle was, in fact, a lava bed.

Sediment cores. These very often displayed a distinct and multiple stratification, indicating that conditions of sedimentation have varied considerably during the time represented by the length of the core. Such stratified sediments appear to be specially common near the equator. Shifts in the latitude of the equatorial counter-current with its attendant strip of divergence in the surface, that is, water rising from lower depths rich in nutrient salts and in plankton, appear to give a plausible explanation for this stratification. In some cases stratification may have been caused by changes in the level of the sea bottom itself or else, in the vicinity of submarine slopes, by 'slumping'. Vegetable remains were prominent in cores from the Gulf of Panama, from the Sunda Sea and the Mediterranean, as well as from the western part of the equatorial Atlantic Ocean. On the other hand, mid-ocean cores of red clay, apparently homogeneous, save for their becoming more compact in the lower levels, were also found in lengths exceeding 40 ft., indicating that sedimentation had there proceeded practically undisturbed for at least one, if not two, million years.

Volcanic ash layers or other layers of coarser grain were frequently found intercalated in the ordinary fine-grained sediment, especially in the Mediterranean but also in the Sunda Sea. Both in the Mindanao Deep and in the Romanche Deep, cores with thick layers of fairly coarse mineral fragments were raised from depths exceeding 4,000 fathoms. In the vicinity of extensive desert regions, as in the Red Sea and off the west coast of North Africa, wind-blown sand was a normal component in the cores.

Components of planktonic origin have been looked for in several of the cores, especially shells of pelagic Foraminifera. Both in cores from the Mediterranean and from the Caribbean, Dr. Fred Phleger has found evidence for considerable temperature variations in the water surface, reflected in the varying composition of the calcareous remains. The most plausible explanation is that these temperature variations have been caused by alternations between cold (glacial) and warm (interglacial) periods during the Quaternary Age. Similar results have been found by W. Schott with cores taken in the open Atlantic. These finds give hopes that submarine chronology may be linked up to the time-scale of continental glaciology. Another possible clue to submarine chronology, at least with cores taken within moderate distances from continental coasts or from forested islands, is derived from a preliminary analysis of the pollen grains found in considerable numbers in cores from the Tyrrhenian Sea. A third possibility is that of radioactive analysis of the upper layers, in which ionium precipitated together with ferric hydroxide from the sea water gives rise to radium, decreasing downwards with the half-period of 82,000 years. Finally, volcanic shards, found in sediment cores and identified from one locality to another, may lead at least to a relative chronology of the different strata, wherever isochronic surfaces can be recognized.

Temperature gradient. In the deep sea bottom, the temperature gradient is one of the outstanding problems of deep-sea geophysics. A special geothermometer, 11 metres long and plunged into the sediment, had been specially constructed for this purpose. Although it worked quite well in other respects, the clockwork used for turning round a tap of the sensitive spirit thermometer it contained generally failed to work at the low temperature of the bottom water. Only two fairly trustworthy values were obtained in the central and the western parts of the Pacific Ocean. Both gave unexpectedly high values for the geothermal gradient, namely, 22 and 26 metres per degree centigrade, so that this particular problem must be left for future deep-sea expeditions to study.

Radium and uranium content. Measurements of the radium and uranium content in large-volume samples of sea water from various localities and depths have confirmed earlier results obtained from a much more limited material. The uranium content, measured in the Institut für Radiumforschung in Vienna, is fairly constant, varying between limits of 1·0 and 1·6 micrograms per litre, with a slight tendency to an increase in great depths. The radium content is always considerably less than the theoretical value in radioactive equilibrium with the uranium (about four units of the thirteenth decimal of a gram per litre), being generally only about one unit of the same decimal place and very often considerably less. Also here a tendency to higher values with increasing depth is manifest. This deficiency in radium already observed in our earlier work supports the hypothesis of a precipitation of the intervening element, ionium, to the sea bottom; this, incidentally, would also explain the generally high content of radium in the red clay and in radiolarian ooze.

Oceanographic studies. Studies of temperature, oxygen and dissolved salts in sea water from different depths were mainly concentrated on sections across the equatorial current system. The analyses, which are now being completed in the laboratory, will afford valuable material for studying the interesting dynamics of the equatorial counter current. The occurrence of light-scattering particles in deep water was also studied, the results indicating that maxima of such particles occur in certain depths.

Biological investigations. Biological work was mainly limited to trawling in great depths in the Atlantic Ocean during the concluding four months of the cruise. Dr. O. Nybelin, director of the Natural History Museum in Göteborg, who conducted these investigations, was greatly helped by Dr. Kullenberg, who worked out the theoretical value of the length

of steel cable required for keeping the trawl on the bottom. Here the deep-sea echograph proved a most valuable asset, since it enabled us to keep the depth in which the trawl was being towed under permanent control and also to pick and choose our trawling ground beforehand, so as to avoid an uneven bottom, dangerous to the gear. Very good catches, both of fishes and of invertebrate organisms, from great depths were made, some of them very rare or even new to science. The deepest haul, made to the north-east of the Virgin Islands, gave conclusive proof that even in depths exceeding 4,200 fathoms (7,600–7,900 metres) bottom-living organisms exist, such as sea-cucumbers and -worms. In all probability even the greatest depths of the ocean are inhabited, although by a sparse and highly specialized fauna.

By means of a large sledge-net towed along the bottom in a depth of about 2,800 fathoms to the south-east of the Bermudas, several hundred manganese nodules, some of them of fairly large size, were obtained. Their rate of radial growth is now being determined by radium measurements in their different layers. Quite near this locality an interesting core was raised by means of a core sampler of specially wide bore. Its uppermost layer was a manganese crust followed by a terracotta-coloured paste rich in iron. But the lower parts of the core also gave a rich display of varying colours.

In general, the results both from the sediment work, the oceanographic series, and the deep-sea trawling lend support to the view that adequate technical resources are now available for extensive research in great ocean depths; such research is of great importance not only for oceanography but also for the almost novel science of submarine geology. A few points which appear to be specially worthy of future study may be mentioned.

(1) The surface layers of the deep-sea deposits in their interrelation with the bottom water. Here water bottles closing at definite heights above the bottom and core-samplers imparting a minimum of disturbance to the semifluid uppermost sediment layer and at the same time giving sufficient material for detailed analysis, centimetre by centimetre, should be used. In connexion with such sampling, the plankton community existing in the upper water layers, especially the foraminifera, should be sampled by means of quantitative plankton catchers.

(2) The raising of long sediment cores has been proved feasible during the expedition, in spite of fairly strong wind and ocean swell. The region we have explored should in future be extended to higher latitudes on both hemispheres. In such long cores reaching well back into the late Tertiary, both the pelagic and the benthonic foraminifera should be studied, with the view of ascertaining by how much the temperatures of the bottom layers were then higher than at present.

(3) The geothermal gradient in the deep-sea bottom should be extensively measured by means of an improved technique. A point of special interest will be to extend these measurements to regions both within and outside areas of pronounced volcanic activity.

(4) Measurements of sediment thickness by means of an improved technique should be carried out in great depths, preferably also by means of depth-charges exploding below the surface of the sediment.

(5) Continuous records of the bottom profile across the oceans should be taken wherever possible. If naval ships on ocean-crossing cruises could be provided with the supersonic echographs of great range now available at moderate costs, their cruises might afford most valuable material both for bathymetrical and morphological studies of the ocean floor, where hitherto so very little is known.

In the first years of this century an international organisation was set up for co-ordinated systematic work in physical oceanography and in biology over the shelf area and the adjacent continental slope off the coasts of north-west Europe. The International Council for Sea Investigations has carried out invaluable work during the half-century of its existence. The much vaster field offered by the deep ocean now seems to call for a similar co-ordination of efforts on an international scale. Great Britain, where deep-sea oceanography was born, would seem destined to take a leading part, on the European side, of this future work.

RESEARCH IN THE COLONIES

WITH its third issue under the title "Colonial Research (1948–1949)"* the collection of annual reports dealing with Colonial research now appears to have taken something like final shape. Under that title the present volume of 134 pages includes the annual report of the Colonial Research Council, the sixth annual report of the Colonial Products Research Council, the fifth annual report of the Colonial Social Science Research Council, the fourth annual reports of the Colonial Medical Research Committee and of the Committee for Colonial Agricultural, Animal Health and Forestry Research, and the second annual reports of the Colonial Insecticides Committee and Colonial Economic Research Committee. That from the Colonial Research Council is the master report covering the whole field, including those of the specialist advisory bodies, and to it are appended a list of schemes approved for research grants under the Colonial Development and Welfare Acts during the period April 1, 1948–March 31, 1949, and of allocations for research under those Acts, 1940–March 31, 1949. Some of the information has already been given in the return of schemes published in July as Colonial 211 and in "The Colonial Territories (1948–1949)" (Cmd. 7715), to which reference has already been made (see *Nature*, August 6, p. 199).

Actual disbursements on research schemes during the year under review amounted to about £750,000 as against £425,760 in 1947–48, and £169,388 in 1946–47. In addition to major schemes already noted as made during the year, this report refers particularly to those for the acquisition and equipment of the Sir Alfred Jones Medical Research Laboratory in Sierra Leone, the preparation of a flora of East Africa, research into the effects of 'Antrycide' injections on cattle in East Africa and provision for the appointments of directors of the projected West African Agriculture and Forestry Research and Veterinary Research Organisations, and for postgraduate training in Great Britain of prospective workers on fisheries and stored products research. A new series of "Colonial Research Publications" was instituted by the Colonial Office for reports by persons engaged on research in the Colonial sphere financed by Government sources, and three reports in this series appeared during the year.

* Colonial Research, 1948–1949. (Cmd. 7739.) Pp. 134. (London: H.M. Stationery Office, 1949.) 2s. 6d. net.

Reviewing the fields of research in succession, the Colonial Research Council records further research by the African Studies Branch of the Colonial Office into the contemporary history and problems of African administration. Lord Hailey was engaged in completing a report on systems of African native administration, including the organisation of the native courts, and the Colonial Local Government Advisory Panel has already proved its worth. Copies of a bibliography of published works on African land tenure are expected to be available shortly. In the sphere of anti-locust research, regional control services have been, or are being, established to prevent the formation of new swarms and thus to protect the agricultural development of Africa, and the work of the Anti-Locust Research Centre has continued to develop in close co-operation with the regional services. Increasing assistance is being given by the Building Research Station to Colonial governments and others interested in Colonial building, and the interchange of information has been facilitated since Mr. C. A. Atkinson took up his duties as Colonial liaison officer at the Building Research Station on June 1, 1948. A survey of costs and standards of accommodation of typical buildings was recently made in each Colony, and the standards which have been adopted for low-cost building are being reviewed.

While there appear to be possibilities in developing marine fisheries in British Guiana, Trinidad, British Honduras, the Caymans and the Bahamas, no great increase in the production of the sea fisheries seems likely elsewhere. There appear to be possibilities in the development of fish production by fish farming in many of the islands. In East Africa the Research Station at Jinja on Lake Victoria has already obtained valuable results in studies of the Mormyrids, the elephant-snouted fish, which has a high food value. The fisheries survey of the Gulf of Aden ended in March 1949, and there appear to be good possibilities for a canning industry in the Gulf. The Mauritius–Seychelles survey continues to show an abundance of fish on the Seychelles, the Aldabras, Cosmoledo, the Saya de Malha, Nazareth and Fortune Banks, the Gt. Brandon and Sudan Banks, Mauritius and Rodriguez, and several shark livers with a high vitamin A potency have been obtained. During the year, plans were made for the establishment of a National Institute of Oceanography as an Admiralty responsibility. Colonial governments are being asked to appoint officers to act as correspondents with the Road Research Laboratory, and in accordance with the recommendations of the Brazzaville Conference, an International Scientific Committee for Trypanosomiasis Research has been established with a permanent secretariat in London, while the French and Belgian Governments have set up a Standing Trypanosomiasis Bureau at Leopoldville. The London Tsetse Fly and Trypanosomiasis Committee, in collaboration with the Colonial Insecticides Committee, continued to review the whole field of anti-trypanosomiasis work in British Africa, and considerable progress was made with the establishment of the West African Institute. It is hoped that experiments which are now in progress will help to evaluate the prophylactic value of 'Antrycide' and extend its practical application.

The report of the Colonial Products Research Council refers particularly to the opening of the Colonial Microbiological Research Institute at Trinidad. This is intended to be a research centre for all the Colonies. The Hankey Culture Collection now comprises 153 cultures, and these have been detailed in a catalogue forwarded to the British Commonwealth Type Culture Collection. Clinical trials have shown that dextrose can replace blood plasma to about 50 per cent, and the director of research of the Council, Sir John Simonsen, has been able to arrange with the Ministry of Food for a sufficient allocation of sugar for a firm to proceed with the trial manufacture of dextrose on a semi-commercial scale. With Sir Norman Haworth's retirement from the chair of chemistry at the University of Birmingham, work on the chemistry of sucrose will continue in Birmingham; but that on starch will in future be carried out by Prof. S. Peat at the University College of North Wales, Bangor. The observation that the so-called 'Q' enzyme converts amylose into amylopectin points to a possible industrial application of the studies of Haworth and Peat of the action of enzymes on these two constituents of starch. In view of the interesting pharmacological properties of the pyridazine derivatives obtained from lævulinic acid by Dr. L. F. Wiggins and his collaborators, a number of compounds are being submitted for clinical trials. The report emphasizes the need of further work before all the problems associated with the development of conophor oil by heat treatment of the seeds from *Tetracarpidium conophorum* can be solved, and the disturbed conditions in Malaya have hindered the collection of rubber seed for the large-scale trials of the production of a second substitute for linseed oil. Prof. T. P. Hilditch's work has also made it clear that the oils obtained from niger seeds, safflower seed and sunflower seed of suitable varieties from East Africa and Rhodesia are of high linoleic acid content and of equal, if not superior, value in the paint industry to soya bean oil. The work has also indicated the importance of environmental conditions, temperature and soil on the cultivation of oil seeds. Work on the germination factor of *Striga hermonthica* indicates that the factor is a carbohydrate. Investigations on the alkylnaphthalenes in collaboration with Trinidad Leaseholds, Ltd., have led to the preparation of an alkylnaphthalene sulphonic acid comparable with the best commercial products in detergent and wetting properties. An analytical survey is being made of Colonial timbers, and saponin obtained from the wood of *Mora excelsa* and related timbers from British Guiana and Trinidad is being investigated.

The Colonial Social Science Research Council has continued to give much attention to the problem of providing an organisation capable of planning and conducting research in the Colonies themselves, and is confident that the solution lies in the creation of regional institutes of social and economic research, although as an interim measure a good case could be presented for the creation by Colonial governments of small departments or research branches to investigate such specific administrative problems demanding urgent remedies as land tenure, native law, etc. The first of these regional Institutes to be established in a Colonial territory is that at Makerere in Uganda; but its director, Dr. W. E. H. Stanier, has recently tendered his resignation after submitting lengthy reports on the requirements of the Institute itself and the social science research needs of Uganda and Tanganyika. A similar Institute has now been established in the West Indies with Dr. H. Dudley Huggins as its first director, and with the governing body of the University College of the West Indies as its own governing body. A third Institute is proposed for Nigeria to serve West Africa, and it is expected

that this Institute will be similarly integrated with the University College at Ibadan. Among the projects in progress are the Ethnographic Survey of Africa, the Survey of the Northern Bantu Linguistic Border, anthropological research on the Mende, Sierra Leone, the social survey of Jamaica and linguistic research in Fiji. New projects undertaken during the year include historical research on the Gold Coast, a study of administration by native authorities in Nyasaland, anthropological studies of the Turkana, Kenya, and in Sarawak and Singapore, and a study of psychological aptitude testing in Nigeria.

The report of the Colonial Medical Research Committee refers to the arrangements being made for the East African Medical Survey, and for the continuation of the Virus Institutes in Uganda and Nigeria on the termination of support from the Rockefeller Foundation. Preliminary arrangements for setting up the East African Bureau of Medical Research have been completed, and arrangements made to take over the research laboratory at Freetown, Sierra Leone, from the Liverpool School of Tropical Medicine. The programme of research in hot-climate physiology is being developed in Nigeria under the direction of Dr. W. S. S. Ladell, while preliminary arrangements have been made for the development of new schemes of research on Bancroftian filariasis and onchocerciasis in East Africa and on loiasis in the Cameroons. Research on malaria in North Borneo continued, while in Malaya trials of the prophylactic value of 'Paludrine', mepacrine and chloroquine undertaken in the plantations of an endemic area appeared to confirm the high suppressive value of 'Paludrine' in *falciparum* and *vivax* malaria. It is also intended to compare the results obtained in control of malaria by D.D.T. or 'Gammexane' spraying of houses and by the use of 'Paludrine' prophylaxis in selected areas. The Malaria Sub-Committee has also drafted recommendations for the prophylactic and therapeutic use of 'Paludrine' for suppression and treatment of malaria.

Work on nutrition has continued at the Field Research Station at Fajara in the Gambia, and senior members of the Human Nutrition Research Unit of the Medical Research Council are now engaged in the Gambia in clinical investigations principally concerned with the prevalent types of anæmia, with liver pathology and œdema, and work has continued to determine the extent to which these conditions depend on malnutrition and zymotic disease. As a preliminary to long-term investigations on filarial infections in East Africa, the Medical Research Council dispatched a research team to Tanganyika to undertake field studies on the effect of hetrazan. The Colonial Medical Research Committee also asked Dr. F. Hawking and Lieut.-Colonel W. Laurie to report on the facilities available for research in filariasis in East Africa, and Mwanza has been selected as the headquarters of a Colonial Office team of which Lieut.-Colonel Laurie will be in charge. The Scrub-Typhus Research Unit in Malaya is investigating the biology and ecology of carrier mites and of their animal hosts. Besides the ecological problems, the vexed question of taxonomy is receiving much attention, and close contact has been maintained with the United States Scrub-Typhus Research Unit, particularly in the field prophylaxis trials of chloromycetin, in which considerable strides were made in the study of the chemoprophylactic potentialities of the drug. Besides its curative value for scrub-typhus, this new antibiotic is effective against gonorrhœal urethritis. Physiological research at Makerere College, Uganda, has covered anæmia, hæmoglobin estimations and levels, and the condition of malignant malnutrition known as kwashiorkor.

The annual report of the Committee for Colonial Agricultural, Animal Health and Forestry Research records the considerable attention given by the Committee to the regional organisation of research in East Africa, as well as in West Africa and the Malayan region. An African Rinderpest Conference was held at Nairobi in October 1948 to consider the control and eradication of rinderpest in Africa, and much attention has been given to the question whether there is any danger of introducing rinderpest into the United Kingdom by the importation of immunized animals or the carcases of immunized animals. An *ad hoc* sub-committee recommended concentration of efforts on the eradication of the disease from wide areas of country containing large cattle populations. An International African Soils Conference held at Goma in November recommended the establishment of a research organisation, an Inter-African Pedological Service, at Yangambi in the Belgian Congo, and also of an International Information Bureau on questions of soil conservation and utilization with headquarters in Paris, and these recommendations are being implemented. The mission sent to Zanzibar in March 1949 to advise on methods to be taken to check the spread of 'sudden death' disease of clove trees on Pemba Island has submitted its report. The Cocoa Research Sub-Committee has put forward tentative suggestions for implementing the recommendations of the Commission of Inquiry into the swollen shoot disease of cocoa in West Africa, and has again closely studied the work of the West African Cacao Research Institute. The Stored Products Research Sub-Committee has been chiefly concerned with the activities of the West African Pest Infestation Survey and particularly with the outbreak of *Trogoderma* infestation among stored groundnuts in the area of Kano, Northern Nigeria.

The Colonial Insecticides Committee reports that the Colonial Insecticides Research Team is now at work at Porton, near Salisbury, and has obtained interesting results on the influence of crystal size on toxicity to mosquitoes and tsetse flies and the application of this factor to the composition of wettable powders. The effects of particle size and distribution on toxicity are being studied. The Colonial Insecticides Research Unit, Uganda, has given much attention to aircraft experiments against tsetse flies, and experiments with impregnated screens indicate that this method may be useful as a subsidiary method of control. Further trials with ground insecticidal smoke generators have confirmed that both D.D.T. and B.H.C. smokes are lethal to tsetse flies, but application still presents difficulties. Sprays of these insecticides have also been used in field experiments on the control of malaria by spraying native huts. The Unit's new headquarters will be in Tanganyika. The need for fundamental research in this field is stressed in the report, which also refers to the work on mosquito eradication in Cyprus, malaria control in Malaya, the malaria eradication experiment in Mauritius, the disinfestation of aircraft, helicopter experiments, the control of grasshoppers on sugar cane in Trinidad, the disinfestation of trains against tsetse and the preliminary trials with herbicides against weeds of groundnuts and with defoliants

on bush vegetation carried out at Kongwa for the Overseas Food Corporation.

The Colonial Economic Research Committee states in its brief second report that the Committee has been concerned with advising the Colonial Office on technical economic problems arising in the appreciation of economic conditions in Colonial territories, and has collaborated with the Colonial Office in preparing a comprehensive programme of Colonial economic research to be undertaken as and when qualified research workers become available. Two research studies undertaken by Colonial Research Fellows, and supervised by the Committee, are being prepared for publication, namely, Miss P. Deane's inquiry into national income, production and expenditure in Northern Rhodesia and Nyasaland, and Miss P. Ady's study of the occupational structure of representative communities in the Gold Coast as influenced by war-time Government expenditure.

J. B. DELAMBRE (1749–1822)

By Eng.-Capt. EDGAR C. SMITH, O.B.E.

JEAN BAPTISTE JOSEPH DELAMBRE, an illustrious French astronomer, was born at Amiens on September 19, 1749. He was educated at the gymnasium of his native town, and there came under the influence of the poet Delille, with whom he began a life-long friendship. Afterwards, he was enabled to attend the College of Plessis in Paris, and at the close of his academic career began to earn a precarious living by the aid of his pen. His knowledge of languages was extensive, and he made many translations from Greek, Latin, Italian and English. He also undertook the duties of a private tutor, continuing meanwhile his own studies in mathematics.

At about the age of thirty-five, Delambre attended lectures at the Collège de France and there formed a friendship with Lalande. His first important scientific work was the preparation of the tables of the newly discovered planet Uranus, for which he received in 1790 a prize from the Academy of Sciences. Two years later, he was awarded a second prize, for his tables of Jupiter and Saturn, and was also elected a member of the Academy.

In 1790 the Revolutionary Government in France brought forward the project of determining a national system of weights and measures, and in connexion with this a commission including Lagrange, Laplace, Pruny and Delambre was formed to consider the matter. Besides the length of the seconds pendulum, two other units of length were suggested, namely, a quarter of the earth's circumference at the equator and a quadrant of the meridian. The latter was the one accepted, and Delambre and Mechain were detailed to measure an arc from Dunkirk to Barcelona. The operation extended over the years 1792–99, and the results were given to the world by Delambre in his work entitled "Base du System metrique decimal", the first volume being published in 1806, the third in 1810. Owing to the unsettled state of the country, the work of measurement was often difficult and dangerous, and at one time the operations were suspended altogether by a decree of Robespierre, who deposed Delambre and some of his colleagues from the commission as being deficient in "republican virtues and their hatred of kings". Arago and Biot eventually extended the arc measured by Delambre and Mechain to Foramentera.

Delambre was given a seat in the Bureau des Longitudes, in 1802 he was appointed inspector-general of studies, and in the following year he was chosen permanent secretary to the Paris Academy of Sciences, in which capacity he wrote many *éloges*, reports, etc. In 1807 he succeeded Lalande at the Collège de France, and in 1808 was made treasurer of the Imperial Ministry. As an acknowledgm his merits the Institute of France in 1810 gave him one of the decennial prizes instituted by Napoleon; but the Emperor for some reason refused to ratify the decision. The latter part of Delambre's life was taken up by his numerous duties and the collection of materials for his great "History of Astronomy". This work appeared in six volumes, five being published between 1817 and 1821 and the last in 1829, five years after his death. He died in Paris on August 19, 1822, after suffering for some time from severe fainting fits.

Delambre was distinguished no less for his impartiality than for his profound learning. "He was a man in whom the love of truth and accuracy was conspicuous. Learned and patient, he spared no pains in acquiring knowledge and in using it to the best purpose. He laboured so earnestly to restore to Hipparchus the credit due to him as to hold the balance between the merits of French and British astronomers. His character was as amiable as his life was blameless, and the frugal and simple habits of his early life were not abandoned when he occupied a distinguished position and was a chevalier of St. Michael and an officer of the Legion of Honour." His *éloge* was pronounced by Cuvier, who paid an eloquent tribute to his memory.

OBITUARIES

Prof. S. H. Reynolds

By the death of Sidney Hugh Reynolds on August 20, geology has lost one who made important contributions both as an investigator and as a teacher. Born at Brighton in 1867, he passed from Marlborough to Trinity College, Cambridge, where he studied natural science and, under the influence of T. McKenny Hughes and J. E. Marr, began to specialize in geology.

He was appointed to the staff of University College, Bristol, in 1894, teaching both geology and zoology under Lloyd Morgan. This wide range of activities was not unattractive to him, for he was fundamentally a naturalist with an interest in all field studies. Indeed, his text-book on "The Vertebrate Skeleton" remained for many years a standard work for students of zoology, while much later he showed how this interest had been continued by undertaking the preparation of Volume 3 (1922–39) of the Palæontographical Society's monographs on the Pleistocene Mammalia, the first two volumes of which had been written by Boyd Dawkins in 1872 and 1878. But his principal work in Bristol was in field geology, and he was appointed to the chair of geology in 1910, a position which he held until his retirement in 1933.

Reynolds's geological writings cover a wide variety of topics. His early work dealt with the Lower Palæozoic rocks of western Ireland; in this he collaborated with C. I. Gardiner, with whom he continued to work for many years. As his interest in the Bristol district grew, he wrote many papers on local

geology, describing the Silurian rocks of the Mendips and the Carboniferous Limestone of many areas. The stimulating association with Vaughan led to great activity in this field, and Reynolds and his co-workers continued for many years to make known the structure of parts of Somerset and Gloucestershire. His views on the Lower Carboniferous were summarized in his presidential address to Section C of the British Association in 1926.

Throughout these years his department produced a flow of men varying in special interests, but all characterized by that width of view which was so typical of their professor. An energetic traveller and an indefatigable collector, he brought together material for an admirable museum. Nor were his energies confined to the work of the University, for he did much to foster the band of amateur geologists for which the Bristol district had long been known, and the geological section of the Bristol Naturalists' Society owes much to his devotion. An excursion handbook to the Bristol district, first published in 1912, contributed to local activities, and also helped to make the area one of the most widely known for student parties.

Prof. Reynolds served for a time on the Council of the Geological Society, from which he received the Lyell Medal in 1928. Among his many services to geology mention must be made of his work as secretary of the British Association Committee on Geological Photographs, which has done so much for the illustration of geological phenomena. The efforts which he made to replace material destroyed by enemy action in order to hand over the collections in good condition will not be forgotten by his colleagues. Always modest and unassuming, charitable in his judgments and warm in his appreciation, Reynolds made many friends and lost none. He will be remembered with gratitude and affection by many besides his own students. He leaves a widow and a daughter.

A. E. Trueman

Prof. Edward L. Thorndike

Edward Lee Thorndike was born on August 31, 1874, and died a few days before his seventy-fifth birthday. In conformity with family tradition, he took his first degree at Wesleyan University and then went to Harvard, where he worked with William James on the methods by which animals learn, a subject which was to be his life task, though in later decades it was the animal 'man' which chiefly interested him, individually and in communities. Then at Columbia University he took the Ph.D. in 1898 with a dissertation which made psychological history, and in the same year James Russell initiated Thorndike's lifelong connexion with Teachers College, Columbia, by inviting him to an instructorship.

Largely on those early experiments were based Thorndike's three laws of learning, of which that called the Law of Effect has evoked most controversy. It is that learning is due to the glow of satisfaction which accompanies success. At first he emphasized equally the importance of the dissatisfaction which follows failure; but in his experiments on humans he considered that he had definitely proved that reward is more effective than punishment, a principle naturally of great importance in school, especially when combined with his stress on the desirability of the satisfaction coming as soon as possible after the success (not to be told until a week later which of one's golf strokes had been good would seriously delay learning !). He thought effect more important than frequency, and pointed out that in the early stages of learning to ride a bicycle we practice falling off much oftener than staying on. His psychology of learning has been attacked as mechanistic, and as not explaining sudden insight into a problem; and it is perhaps a little crude. But it works.

In 1904 his "Introduction to the Theory of Mental and Social Measurements" appeared, in the same year as Spearman's paper on the "Theory of Two Factors". Thorndike took up arms against Spearman's view, and though they approached one another somewhat in later years, they can never be said to have agreed. Thorndike's "Quantity Hypothesis", expounded in "The Measurement of Intelligence" (1926), perhaps indicates the nearest approach. In that same book appeared Thorndike's famous "C.A.V.D." tests of intelligence and his attempt at an absolute scale of intellect.

In later years Thorndike turned to the study of communities, his chief publication here being "Human Nature and the Social Order" (see *Nature*, Sept. 27, 1941). Like all his books and papers, this is too meaty to be light reading. But every here and there a striking phrase flashes out.

Thorndike received many honorary degrees, was a member of the U.S. National Academy of Sciences, and president in 1934 of the American Association for the Advancement of Science.

Early in his career he bought a wide tract of land up the Hudson, in what was then primeval woodland, built himself a house, and encouraged colleagues to settle around him, until there was quite a colony, to whom he was the tribal chieftain. He adored his wife, who survives him, as also do his daughter and three sons, all scientific workers, Robert Ladd being the psychologist among them. "Eddie" Thorndike had a great heart, as well as a great mind, and I wish that I had more space, and a readier pen, to tell of his wisdom and goodness.

Godfrey Thomson

Mr. H. O. Newboult

Harold Newboult, who died on August 11 at the age of fifty-two after a short illness, was educated at Kingswood School and served in the First World War as an artillery officer on the Italian front. He took up his mathematical scholarship at Balliol College, Oxford, after the War; his undergraduate career, which included the sharing of the junior mathematical scholarship with E. C. Titchmarsh, was all that was expected of an able and gifted mathematician. Immediately after taking finals he succeeded his tutor, J. W. Russell, as lecturer at St. John's, and in 1925 was appointed fellow and tutor at Merton.

For some twenty-five years Newboult taught the mathematicians at Merton and St. John's, acquiring a high reputation as a tutor. Throughout this time he gave lectures, which were not only exceedingly popular with undergraduates, but which became an important and essential part of the Oxford mathematical school. He also undertook much examining and an increasing burden of administrative work in his College and the University. He acted as bursar of Merton in the war years and was proctor during 1944–45. He had wide interests in both the academic and athletic sides of University and College, and was for a long time treasurer of the Greyhounds R.F.C. In 1946 he published his book on "Analytical Method

in Dynamics", and with T. W. Chaundy was writing a book on analytical geometry.

Newboult was an excellent tutor and lecturer in the whole range of the mathematical school; but his particular contribution to mathematics lay in his wide knowledge of geometry, always available to colleagues and undergraduates alike. For many years and in various branches of the subject his lectures and teaching stimulated young men who have since established their own reputations in this field. No mere recital of his successes as a teacher and administrator can do him full justice. His influence was wide, for he brought to all his work the attitude of a scholar, remarkable acuteness and consistent fairness of mind. J. H. C. THOMPSON

Dr. G. S. Baker, O.B.E.

DR. GEORGE STEPHEN BAKER, who died on August 16, had a world-wide reputation as a man of science and naval architect, who successfully applied the science of hydrodynamics to the design of merchant ships. Dr. Baker was born in 1877 and received his early training (1892–96) at the Royal Dockyard, Portsmouth, as a shipwright apprentice. For his marked ability he was selected by the Admiralty in 1896 to continue his studies at the R.N.E. College, Keyham, for a year, followed by three years at the R.N. College, Greenwich, where he graduated in 1900 with a first-class professional certificate. He joined the Royal Corps of Naval Constructors, and, after working at Whitehall, he spent five years as Mr. R. E. Froude's assistant at the Admiralty Experiment Works at Haslar, carrying out ship model experiment work. He was then appointed professional secretary to Sir Philip Watts, director of naval construction. In 1910 he was selected by the Royal Society to become the superintendent of its new hydrodynamics laboratory at the National Physical Laboratory, a post which he occupied for thirty-two years. On his retirement at the age of sixty-five in 1942, he remained on the staff until the end of the War, engaged on special research work. From 1945 until his death, he carried out work for the B.S.R.A.

While at Teddington, Dr. Baker read forty-three papers of high scientific merit before various technical societies and was awarded gold medals by three of them for outstanding research. He was a vice-president of the Institution of Naval Architects. He became a doctor of science of the University of Durham in 1935. For his extremely able and timely work for the fighting services during 1914–18 he twice received the thanks of the Admiralty and was awarded the O.B.E.

Dr. Baker's fundamental researches in skin friction and propeller design greatly advanced the science of ship design, and his researches into the effect of changes in the form and dimensions of ships upon their resistance have become classics in ship designing circles. So successful were these researches that a direct result has been the saving of several million tons of fuel annually in the propulsion of ships.

Dr. Baker combined great technical ability with a driving force which enabled him to overcome all obstacles in the way of success. He possessed a singularly clear-thinking mind, and, by his accurate foresight of the future needs of shipowners, he was able to plan his researches so that he was almost always ready with new data before they were required. He became an authority on all matters where science touched ship design, and he served as an expert witness on cases of dispute and on many committees dealing with the resistance and propulsion of ships. Dr. Baker always commanded the respect and confidence of those with whom he worked, and his opinions were eagerly sought by those in difficulty. His close application to research work throughout his life left little time for hobbies, but he delighted to browse over early editions in libraries and bookshops, to garden and, when possible, to indulge in his love of sailing.

He is survived by his widow, three sons and a daughter.

NEWS and VIEWS

Geography at the London School of Economics: Prof. R. O. Buchanan

DR. R. OGILVIE BUCHANAN, who has been appointed to the chair of geography in the London School of Economics and Political Science, took his first degree in the University of Otago. After serving with the New Zealand forces during the First World War, he returned to Great Britain and studied at the London School of Economics. He has since served on the staff of the Department of Geography at University College, London, and he was elected to a readership in 1936. He has worked within the field of economic geography, publishing papers on the hydro-electric power and the agriculture of his native land, and his important monograph on the "Pastoral Industries of New Zealand", published by the Institute of British Geographers, is an admirable example of geographical method informed by economic insight. He has since made contributions to the study of plantation agriculture and world wheat supplies and is the author of a book on the "Economic Geography of the British Empire". He served with distinction as a senior maps officer with the Royal Air Force during the recent War. The post to which he has now been elected is well adapted to give opportunity for the development of economic geography as a sound discipline deriving not from geography alone but also from economics and the kindred social sciences. The School of Geography to which he goes, and which is conducted jointly with King's College, is one of the largest in Great Britain and has heavy teaching and research commitments to the Faculties of Arts, Science and Economics. Prof. Buchanan's experience and interests will greatly strengthen the work in the Faculty of Economics.

Botany at Delhi: Prof. P. Maheshwari

PROF. P. MAHESHWARI has recently been appointed professor of botany in the University of Delhi. He was born on November 9, 1904, at Jaipur in Rajputana. He took the B.Sc. and M.Sc. degrees in the University of Allahabad, and during 1927–30 he worked as research scholar at that University, being awarded the D.Sc. degree in 1931. He began his teaching career as lecturer in botany in Agra College (1930–37) and the University of Allahabad (1937–39). In 1939 he was appointed reader in botany and

head of the Biology Department in the University of Dacca, and was later promoted to a professorship.

Prof. Maheshwari's chief interest lies in angiosperm morphology and embryology, on which more than 150 papers have been published by him and his collaborators. He is the author of a book on the embryology of angiosperms which is in course of publication. He is also the editor of another book entitled "Manual of Embryology", to be published in due course. His work has received considerable recognition both in India and abroad. In 1934 he was elected fellow of the Indian Academy of Sciences, and, in 1935, fellow of the National Institute of Sciences, India. He is the president-elect of the Botany Section of the Indian Science Congress session to be held at Poona in January 1950. In 1947 he was made corresponding member of the American Botanical Society and honorary foreign fellow of the American Academy of Arts and Sciences. Recently, he has been elected one of the vice-presidents of the International Botanical Congress to be held at Stockholm in 1950, and chairman of the Section of Plant Embryology of the International Union of Biological Sciences. He has a personal collection of material and literature on angiosperm embryology which may well be the richest in the whole of Asia.

Bacteriology at Guy's Hospital, London : Dr. R. Knox

Dr. R. Knox, who is forty-five years of age, has been appointed to the University of London chair of bacteriology, tenable at Guy's Hospital Medical School. Before taking up medicine, he held a classical scholarship at Balliol College, Oxford, took first-class honours in Greats, and incidentally coxed the University boat in 1925. He did his clinical work at St. Bartholomew's Hospital, London, taking his Conjoint qualification and his M.B., B.S. London, in 1932. After holding house appointments and a chief assistantship at St. Bartholomew's, Dr. Knox spent a year at the London School of Hygiene and Tropical Medicine working on bacterial metabolism. He took his London M.D. and his M.R.C.P. in 1934. In 1935 he was appointed demonstrator in pathology in the University of Cambridge. In 1937 he became a member of the scientific staff of the Imperial Cancer Research Fund. At the outbreak of the War in 1939, Dr. Knox joined the Emergency Public Health Laboratory Service, and was in charge of laboratories at Stamford and at Leicester. At the end of the War he was made director of the Public Health Laboratory in the University of Oxford. Dr. Knox's chief interest has been in bacterial metabolism, especially in the development of selective media, and in the spread of infectious disease under field conditions.

National Research Council, Canada : Merck Fellowships

The National Research Council of Canada has awarded Merck Fellowships in the natural sciences for the year 1949–50 to Dr. D. A. I. Goring, Department of Physical Chemistry, McGill University, for work in colloid science under Prof. F. J. W. Roughton, at the University of Cambridge; and to Dr. M. J. Miller, Instititute of Parasitology, Macdonald College, McGill University, who will pursue his studies in medical parasitology and clinical tropical medicine at the School of Tropical Medicine, University of Calcutta. The purpose of Merck Fellowships is to give special training and experience to young men and women who have demonstrated marked ability in research in chemical or biological science and who wish to broaden their fields of investigation. These fellowships are supported by Merck and Co., Ltd., and the selection of fellows is made by the Merck Fellowship Board of the National Research Council of Canada.

Dr. D. A. I. Goring was born in Toronto, Ont., and graduated at University College, London, in 1942, with a B.Sc. degree. After serving with the Royal Air Force during 1943–46, he entered McGill University as a graduate student in physical chemistry under Dr. Otto Maass, and received his Ph.D. in 1949. Dr. M. J. Miller was born in Saskatoon, and graduated in biology with the B.Sc. degree from University of Saskatchewan in 1934, obtaining his M.Sc. in animal parasitology from McGill University in 1936. Entering the School of Tropical Medicine, Tulane University, New Orleans, in 1936, he pursued his investigations in this field during the next three years and obtained the Ph.D. degree in medical parasitology in 1939. Returning then to Canada, he became lecturer and research assistant at the Institute of Parasitology, Macdonald College, where he has remained apart from service in the Royal Canadian Army Medical Corps during 1942–46. Since 1948 he has been associate professor and research assistant at the Institute.

Oliver Memorial Fund Award : Dr. H. F. Brewer

The second award of the Oliver Memorial Fund for service in connexion with blood transfusion has been made to Dr. H. F. Brewer, clinical pathologist to St. Bartholomew's Hospital, London. Dr. Brewer has been medical officer to the British Red Cross London Blood Transfusion Service for sixteen years, and has been intimately connected with the progressive development of this pioneer service. Throughout the Second World War, he was the director of a London Blood Supply Depot. Dr. Brewer has written miscellaneous papers on many aspects of transfusion, including the criteria of satisfactory grouping serum, the technique of blood grouping, the blood donor and the assessment of the value of stored blood, and he has been a major contributor to a new standard text-book entitled "Blood Transfusion".

The Labgear-Harding Microdissector

The Labgear–Harding micro-dissector will be of great value to those workers who require a method of manipulation and dissection under the microscope intermediate between direct hand manipulation and the extremely sensitive manipulators of the de Fonbrune type. This inexpensive and well-designed instrument consists of an individual manipulator for each hand, and clamps readily on to the stage of an ordinary binocular stereoscopic microscope. It is designed primarily for use at magnifications up to 100 × (erect) and functions extremely well within this range. Each manipulator embodies a small pantograph which can work with ample movement in all three dimensions. Backlash in all working joints is effectively eliminated by using hardened steel balls under an adjustable pressure as the pivots. Small adjusting screws are provided which enable the pressure and hence friction on the joints to be finely controlled, so that the mechanism is not subject to movement under its own weight and so that the desired motion of the needles is very smooth.

At present the makers (Labgear, Ltd., Cambridge, England) supply two fine tungsten needles

as the tools. It is almost certain that users of this instrument will require to fit a diversity of tools, both of metal and glass, which they will want to fashion for themselves. The present method of attachment of these tools will call for some redesigning if this is to be realized, and experience will soon show the best method to adopt. The makers are now experimenting with a micropipette attachment. The instrument is simple to assemble, is robust and compact. Since the movements of the needle points follow exactly the movements of the hands, there is no awkward mental translation to be done. A novice can therefore use the instrument proficiently at the first attempt. Manipulations can be conducted simultaneously with both hands, and the makers provide a lever device for operating the coarse adjustment of the microscope with the knee while both hands are engaged. Although this appears to function satisfactorily, it seems unsound in principle to have such a heavy attachment on the coarse adjustment shaft. Uneven wear of bearing, rackwork and slide may very well occur after prolonged use.

Television Standardization

At the Stockholm meeting of the International Consultative Committee on Radiocommunication (C.C.I.R.), held in July 1948, a number of study groups were formed to deal with the various technical questions and recommendations made by the conference (see *Nature*, **163**, 493; 1949). One of these international study groups has recently met in Zurich to discuss the possibilities of standardizing television techniques on a world-wide or regional basis, particularly from the point of view of facilitating the exchange of programmes between national television services. Representatives of the United States of America, of ten European countries and of some operating organisations interested in the subject attended the meeting. One outcome of this Zurich conference was an Anglo-French agreement recommending the adoption by both countries of a definition standard of 405 lines, which is the present British system. While accepting this standard, France will continue experimental transmissions on the higher definition of 819 lines. Other European countries, where no public television service operates at present, pressed for the adoption of a 625-line transmission standard; but no agreement was reached on this point. Arrangements were formulated for the continued study of this and other matters relating to standardization. Further meetings in London, Paris, Eindhoven and New York were planned to permit the latest developments in television to be viewed by the delegates.

Health Interests of Children

In an interesting article in a recent issue of *Health Education* (**7**, No. 2; April 1949), Arthur J. Lewis describes an attempt which is being made by the Denver, Colorado, public schools to develop a functional health instructional programme which will extend through all age-groups from five to eighteen years. To begin with, a small group of classroom teachers was given the task of identifying the kinds of health experiences which might be provided for children to help them to develop desirable health behaviour. A series of projects was inaugurated in order to learn more about the health needs of children, their health interests and their developmental characteristics. It was soon found that while much is already known about the health needs and developmental characteristics of children, little study has been reported on the health interests of children at each age limit. To try to find out some of the information they required, the committee of teachers carried out some original research to determine pupil interests in health. 3,600 children took part in the investigation and were carefully chosen to represent the various socio-economic groups in Denver. The reactions of boys and girls to questions in dental health, nutrition, physical fitness, personality development, sex education and other health matters were recorded separately, and the combined results were used to build up a health instruction programme in the Denver public schools. Original investigations of the Denver type could profitably be carried out among all age-groups and all classes in Great Britain to determine the way of promoting better health.

New Method of Synthesizing Vitamin A

In connexion with the recent publication of the Medical Research Council Report on "Vitamin A Requirements of Human Adults" (*Nature*, August 6, p. 212), it is of interest to note that the Warner Institute of Therapeutic Research in New York has announced a new method of preparing on an industrial scale synthetic vitamin A from β-ionone, which is obtained from lemon grass oil. Said to be completely free from fishy odour and taste, this is built up from the eighteen carbon-atom compound first described by Sir Ian Heilbron, by the addition of two more carbon atoms and the reduction of the vitamin A acid with lithium aluminium hydride. The product is to be placed on the American market by Wm. R. Warner and Co., Inc., of New York, in the form of gelatin capsules of 25,000 U.S.P. units each.

Plant Diseases in South Africa

Dr. Vincent A. Wager has published, from the Botanical Station, Durban, several brief articles dealing with crop diseases in "Farming in South Africa". Reprint No. 28, May 1946, deals with blossom end rot of tomatoes, and mentions the beneficial effect of surface mulching. The egg-plant varieties Kopek and Matale are resistant to bacterial wilt (Reprint No. 37, June 1946). Further work includes crosses of these resistant varieties with a third variety, Terong Gowok, which is practically immune, but has small, round, useless fruits. It is suggested in Reprint No. 73 (Oct. 1947) that spores of the rust fungus *Kuehneola albida* should be sprayed on the American bramble, *Rubus fruticosus* var. *Bergii*, in order to destroy the host, which is an aggressive weed. The fibre-plant *Phormium tenax* is badly attacked by a wilt disease in South Africa. Reprint No. 75 (Nov. 1947) describes this malady, which is caused by *Fusarium oxysporum*, forma *Phormii*. It appears to owe its severity to excessive soil water. Reprint No. 80 (given as 30) (June 1948) describes the serious black spot disease of citrus fruits, caused by the fungus *Phoma citricarpa*. Infection takes place when the fruits are very small, but develops quickly after they are picked, especially when the temperature is high. Several control measures are mentioned briefly, and it is recommended that no fruit be exported from affected orchards, unless cold-storage facilities are immediately available.

New Zealand Earthquakes

At the five New Zealand seismological observatories, twenty-three strong distant earthquakes were

registered during the two-monthly period, November–December 1948, and in addition there were twenty-six local tremors in New Zealand. The greatest of these latter to be felt was probably that at Collingwood (Modified Mercalli scale 4–5) on November 11, and the second largest (scale 4) on December 28 in the west and south parts of North Island and the north part of South Island. The greatest on the instrumental scale (5½–6) occurred on December 8 from an epicentre near lat. 34° S., long. 179° E., and the second greatest on December 7 (5½–6) from an epicentre near lat. 39·5° S., long. 179·5° E. The latter was felt at Wellington with Modified Mercalli scale 2.

Astronomy in Poland

A RECENT issue of *Rocznik Astronomiczny Obserwatorjum Krakowskiego* (International Supplement No. 20, 1949), edited by T. Banachiewicz and published in Cracow, is devoted primarily to eclipsing binaries, this portion occupying seventy-seven pages of the work. At the end useful formulæ with tables are given for various astronomical computations, especially adapted for computing machines. The new method, which deals with the solution of the normal equations, is fully explained and will prove very helpful to computers. Other matters dealt with are the precessional coefficients, the obliquity of the ecliptic and occultations of stars by the moon during 1949 at Poznan, Wroclaw, Torun, Cracow and Warsaw.

Sources of Statistical Information

A PROJECT recently initiated by the Royal Statistical Society is likely to be widely welcomed. The Council of the Society has invited a number of experts to prepare a series of articles dealing with the sources of statistical information, and the characteristic pitfalls to be avoided in its interpretation, in each of several fields of study. In the first instance the articles will be published in Series *A* of the Society's *Journal*; but they will afterwards be made available in reprint form, price 1*s*. each, post free. The first two surveys, "United Kingdom Merchant Shipping Statistics", by Prof. M. G. Kendall, and "Medical Statistics", by Prof. M. Greenwood, have already appeared, while the third, "Statistics of the Censuses of Production and Distribution", is being prepared by Mr. H. Leak.

Scholarships for Technology in the United States

SOME fifty postgraduate scholarships, for the study of technology at selected universities and technological institutions in the United States, are being offered to students in Great Britain who hold a good honours degree in pure science or technology and are now working in industry or research associations or teaching in universities or technical colleges. The scholarships will provide for fees, books and travelling expenses in the United States and a maintenance allowance of 1,800 dollars per annum, all of which will be paid for from funds provided by the Economic Co-operation Administration. The cost of the passage to the United States and return will be met from public funds. Successful candidates will be expected to take up their awards in February 1950. The awards will be tenable initially for a year, but may be extended for a second year. A considerable part of the time will be spent in selected industrial establishments. Further details can be obtained from the University Grants Committee, 38 Belgrave Square, London, S.W.1.

I.C.I. Research Fellowships in Pakistan

THE Pakistan Association for the Cultivation of Science has accepted an offer from Imperial Chemical Industries, Ltd., to provide the sum of 160,000 rupees (£12,000) for research fellowships in chemistry, physics and biology at universities or institutions in Pakistan, over a period of five to seven years. Each fellowship will be worth about 400 rupees per month, and will be for two years with a possibility of extension to three. In addition, fellowship holders would be given a grant to cover expenses for special apparatus and materials. The Pakistan Association for the Cultivation of Science will make appointments to, and control, the fellowships, which will be open to persons irrespective of sex, race or religion, the overriding consideration being their scientific fitness.

This new gift by I.C.I. is in furtherance of its policy of encouraging fundamental research wherever facilities exist. Since 1944, the firm has provided £48,000 a year for research fellowships at the Universities of Birmingham, Cambridge, Durham, Edinburgh, Glasgow, Liverpool, London, Manchester and Oxford. In 1945, an annual grant of £4,800 to the University of Leeds was announced, and last July a grant of £2,500 per annum was made to the University of St. Andrews for the establishment of a hall of residence for graduates and undergraduates engaged on research. I.C.I. also makes grants of money, totalling about £25,000 a year, to the chemical departments of universities for the purchase of chemicals and apparatus for research work.

Beilby Memorial Awards

FROM the interest derived from the invested capital of the Sir George Beilby Memorial Fund, at intervals determined by the administrators, representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, awards are made to British investigators in science to mark appreciation of records of distinguished original work by younger men. Preference is given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy, and awards are made, not on the result of any competition, but in recognition of continuous work of exceptional merit, bearing evidence of distinct advancement in science and practice. In recent years the amount of each award has commonly been 100 guineas. Awards from the Fund may be made early in 1950, and the administrators will be glad to have their attention directed to outstanding work of the nature indicated, not later than December 31, 1949. Communications should be addressed to the Convenor, Administrators of the Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

Announcements

BY an Order of the Committee of Privy Council for Medical Research, made after consultation with the Medical Research Council and with the president of the Royal Society, the following have been appointed to be members of the Medical Research Council from October 1: Dr. N. Hamilton Fairley, Sir Percival Hartley and Prof. J. McMichael.

ERRATUM. In *Nature* of July 9, p. 77, col. 1, paragraph 3, line 3, the reference should be to redox indicators with E_0 values appropriately higher than that of the arsenite–arsenate system, and not "approximately higher" as printed.

SEPARATION OF SUBSTANCES RELATED TO ASCORBIC ACID

By Dr. L. W. MAPSON and Dr. S. M. PARTRIDGE
Low Temperature Station for Research in Biochemistry and Biophysics, Cambridge

THE method of paper partition chromatography has in recent years been widely used for the separation, detection and estimation of closely related compounds. We thought it of interest to determine to what extent it could be used to differentiate *l*-ascorbic acid from some of its isomers and from other closely related dienols. Simple titration methods using 2 : 6 dichlorophenolindophenol give a reliable estimate of the vitamin content of most of the common foodstuffs, as shown by the close correspondence between chemical and biological results[1–3]. A method proposed by Roe and Kuether[4], which is based on the formation of a coloured condensation product of 2 : 3 diketogulonic acid with 2 : 4 dinitrophenylhydrazone, also gives results which are generally in agreement with those of the indophenol method.

However, neither of these methods will differentiate *l*-ascorbic acid from its isomers or related dienols, such as reductone, reductic acid, hydroxytetronic acid, and dihydroxymaleic acid. Some of these substances are known to be produced during the processing of foods[5–7], and *d-iso*ascorbic acid has been added to quick-frozen fruits to prevent browning.

Methods have been proposed whereby the reaction of the indophenol dye with ascorbic acid may be made more specific. Such methods include one based on the different rates of condensation of *l*-ascorbic acid and other dienols with formaldehyde[8–10], and one based on the different rates of reaction with indophenol dye[11]; but these modifications will not allow differentiation of *l*-ascorbic acid from either hydroxytetronic or *d-iso*ascorbic acids.

A tentative method recently proposed by Trotter, Thompson and Wokes[12], based on difference in the infra-red spectra of these substances, may permit of a certain differentiation, although as pointed out by the authors the spectra are so complex that in a mixture of substances differentiation would be very difficult.

The following work was therefore carried out to determine how far paper partition chromatography would permit a qualitative detection of *l*-ascorbic acid in the presence of these other dienols. To what extent this has been accomplished is indicated below, and since the results are generally promising it is hoped to continue this work to enable a more quantitative estimate to be made.

The behaviour of ascorbic acid and dehydroascorbic acid on filter paper chromatograms has been reported by one of us[13]. In this work the reaction of ascorbic acid with cold silver nitrate – ammonia was used to locate its position on the chromatogram. Dehydroascorbic acid was located by its reaction with the same reagent on heating the paper, but when this substance was prepared by oxidation of ascorbic acid with iodine, interference due to iodide ions was observed (note added in proof to ref. 13, March 1948).

While silver nitrate – ammonia is a useful spraying reagent where it is also desired to establish the presence of reducing sugars or the oxidation products of the dienols, it is frequently of advantage to use a more specific reagent, and the indophenol dye commonly used for the estimation of ascorbic acid serves well for this purpose. The reagent was prepared by dissolving 2 : 6 dichlorophenolindophenol (0·8 gm.) in water (1 litre) and diluting the solution with an equal volume of ethanol. On spraying the chromatograms with the dye solution, ascorbic acid and related dienols react immediately and appear as sharply bounded colourless spots on the dark blue background.

The apparatus and technique adopted was generally that described by Consden, Gordon and Martin[14] for the amino-acids. A large number of different solvent mixtures was investigated to determine those most suitable for the separation of members of this series. In general, the presence of acid in the solvent mixture appeared to be necessary (*a*) to suppress the ionization of the acidic substances and thus to prevent 'tailing', (*b*) to assist in stabilizing the dienols during the course of the run. Nevertheless, successful results were obtained by use of the weakly basic solvent collidine, and a fraction distilled from technical collidine (b.p. 172°) gave well-defined spots and reproducible mobilities. In order to suppress the catalytic effect of copper, irrigation of the chromatograms was carried out in the presence of a low concentration of hydrogen cyanide obtained by the addition of a small quantity (5–10 mgm.) of potassium cyanide crystals to the aqueous solution contained in the bottom of the tank. With hydrogen cyanide present, the use of stainless steel troughs was permissible, although in experiments of this sort glass troughs may be advantageous.

The accompanying table shows the results obtained with the three solvent mixtures found to be most suitable. These were made up as follows: (1) butanol, glacial acetic acid and water were shaken together in the proportion 40 : 10 : 50 by volume[15] and the upper layer used in the trough; (2) glacial acetic acid was added to freshly steam-distilled phenol, to a con-

	Colour reaction			R_F values on Whatman No. 1 paper at room temp. (15–18° C.)		
	Indophenol	$AgNO_3$–NH_3 Room temp.	$AgNO_3$–NH_3 100° C.	(1) Butanol-acetic (KCN)	(2) Phenol-acetic (KCN)	(3) Collidine (KCN)
Ascorbic acid	White	Black	Black	0·37	0·35	0·40
*Iso*ascorbic acid	White	Black	Black	0·38	0·40	0·41
Hydroxytetronic acid	White	Black	Black	0·63	0·62	0·49
Reductone	White	Black	Black	0·63	0·66	0·46
Reductic acid	White	Black	Black	0·64	0·78	0·40
Dehydroascorbic acid	—	Light brown	Dark brown	0·41	0·38	0·44

centration of 1 per cent by volume, and the mixture shaken with an equal volume of water; after equilibration at room temperature the lower layer was used in the trough; (3) technical collidine was refluxed for 6 hr. over solid potassium permanganate and then distilled; a middle fraction (b.p. 172° C.) was shaken with water and the upper layer used in the trough.

Since the presence of hydrogen cyanide precluded the use of a constant-temperature room, the R_F values[14] given in the table (average values from five determinations) were obtained at room temperature. It is clear from the results in the table that the greatest separations were obtained by the use of the phenol–acetic acid mixture, and it is of particular interest that the separation of ascorbic acid and *d-iso*ascorbic acid from mixtures of the two is possible in this solvent. It should be pointed out, however, that the problem of separating these two substances when present in extracts of biological material may be more difficult and has not yet been attempted.

The spots due to the dienols were regular in shape, but that due to dehydroascorbic acid was markedly elliptical and was frequently accompanied by a second smaller spot of low and rather variable R_F value. (R_F in butanol–acetic acid, 0·04–0·07.) Since these secondary spots approximately coincided with those given by the sodium salt of diketogulonic acid, it was inferred that their presence was due to the opening of the lactone ring of dehydroascorbic acid during the course of the run.

We wish to acknowledge the assistance of Mr. D. F. Elsden and to thank Prof. T. Reichstein for a supply of reductone and reductic acid.

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THIRD WORLD FORESTRY CONGRESS

THE first World Forestry Congress was held in Rome in 1926 and the second in Budapest in 1936. The third was convened in Helsinki at the invitation of the Government of Finland in accordance with a proposal adopted at the third session of the F.A.O. (Food and Agriculture Organisation) Conference. Twenty-nine nations were represented, the Congress being held during July 10–20 this year. Representatives of international organisations were present, such as the United Nations and its Economic Commission for Europe, the F.A.O. of the United Nations, the International Union of Forest Research Organisations and the Scandinavian Forestry Union. 406 full and 125 associate delegates attended.

The first meeting was held on July 11 in the Great Hall of the University. The Congress was opened by the Prime Minister of Finland, Mr. K. A. Fagerholm, and welcomed by His Excellency J. K. Paasikivi, president of the Republic of Finland. Messages were brought from the Secretary-General of the United Nations and the Director-General of F.A.O. and read by their representatives, Mr. D. Roy Cameron and M. Marcel Leloup.

A provisional programme had been laid down by the organising committee and was accepted, the work being allocated to five sections: (1) Sylvics and Sylviculture; (2) Forest Surveys; (3) Forest Economics including Forest Policy; (4) Forest Utilization; (5) Forest Industries. As it turned out the divisions of some of the sections were not sufficiently clear cut, and overlapping took place, especially in the case of sections 1 and 3. Prof. Eino Saari, who had been president of the organising committee, was elected president of the Congress with two co-presidents (U.S.A. and U.S.S.R.) and five vice-presidents. Chairmen and vice-chairmen of the sections were appointed with *rapporteurs* and so forth. Mr. M. H. Leppo (Finland) was elected secretary-general.

The opening ceremony concluded, the Congress then elected the officers as above-mentioned. The second plenary session commenced in the afternoon and was devoted to papers of world-wide interest by representatives of F.A.O. with one additional paper. The F.A.O. papers were read by M. Marcel Leloup on "General Aspects of World Forestry" and Mr. Harrison on "Forest Resources and Human Needs of Wood". The additional paper was by Prof. E. P. Stebbing on "Catchment Areas and Water Supplies", and the last "Le passage de la Forêt Vierge à la Forêt Amenagée" by M. François. The other two papers by F.A.O. representatives were read the following morning. They dealt mainly with sylviculture, but in the second there was controversial matter; the writer claimed that high-quality timber was no longer required but only small-sized timber quickly grown. A Canadian delegate put the opposite case, pointing out that Canada had for long provided parts of the world with high-quality timber and considered its production essential to fill certain market requirements—a view strongly supported by many delegates.

Since a large number of papers read had been submitted to the organising committee, with brief abstracts, before the Congress opened, it is difficult to say what influence on the progress of the Congress in its various sections was exerted by the opening F.A.O. papers. But inevitably points made in these latter came up in the discussions which took place in every section, in each of which an F.A.O. representative was on the platform. Unfortunately and perhaps inevitably, some of these discussions and the subsequent resolutions they gave rise to in a particular section were reproduced in meaning, if not in actual words, in one or more of the others.

For the general outcome there can be little doubt that the discussions and the resolutions they gave rise to and accepted, after drafting, by the Congress as a whole, should have a greater chance of producing results than was the case after the Rome 1926 Congress, at which I was present and from which few practical results were achieved. As to the second at Budapest, war broke out too soon after to make it possible to say that governments had realized their neglected responsibilities in these matters.

The chief outcome of the third Congress has been the recognition that the industrialist has just as much responsibility as the forester, not only in making known his demands, but also in adapting his methods of utilizing forest produce so as to take all the forms in which this produce is converted in the forest, thus reducing the enormous wastage of the past. In the words of the report, "it is the responsibility of technical research and industrial development to provide suitable outlets for all parts of the forest crop and to adjust conversion methods and uses to the limitations of sound sylviculture". It is not too much to say, looking back on the past history of the forests of the world, that, if this recommendation can be given real and practical effect, it will prolong the life of what is left of the virgin forests of the world by a considerable period. The following paragraph from the report contains both old and new aims: "The protection of forests from destruction, the establishment of forest inventories, the systematic management, the reduction of waste, the improvement of wood utilization and the increasing consumption of forest products in the interests of better living standards are objectives which have moved from the sphere of discussion to that of generally accepted truths". There still remain the governments, however. Until they give more than lip service to the ever growing importance of the world forest problems, some of the views expressed and affirmed here are unattainable. One of the most pressing is the paucity and numerical weakness of highly trained forest staffs in many countries. Without the latter an appreciation by governments of the value of forests for soil conservation and other protective values as well as their vital contribution of forest products is of little use. What is hoped by F.A.O. and a good many senior experienced forest officers is that governments, business men and the general public have at length come to recognize that the forest, for one reason or another, or for several reasons in a particular country, must be guarded from further spoliation and must be placed under efficient management. The future world forestry position is certainly greatly strengthened by now having a body like the forestry branch of the Food and Agriculture Organisation with a watching brief for individual governments and for the world at large.

The Congress's general recommendations on policy are as follow: "The Third World Forestry Congress affirms its belief: (*a*) that each country should have for its territory a forest policy aiming at the maintenance of a reasonable forest area and also the conservation and use of forests on the basis of continuous and improved production; (*b*) that forestry legislation, research, education of forest owners and workers, and training of a sufficient number of professional foresters and technicians—all in conformity with the constitution and structure of each country—constitute essential elements of such a policy".

Commending the work of the F.A.O. it recommends: "(*a*) that F.A.O. prepare a statement of forestry principles for the consideration of member nations; (*b*) that F.A.O. assist nations now formulating their forest policy; (*c*) that the annual conference of F.A.O. explore whatever further steps member governments consider appropriate for the application of the principles stated above".

The report then deals with the summarized discussions and resolutions of the several sections as classified and collated by the Drafting Committee.

E. P. Stebbing

CONFERENCE ON ELECTRON MICROSCOPY, DELFT

ELECTRON microscopy has reached a stage at which it is necessary and fruitful to take stock: to measure the progress which has been made in eighteen years, and to define the directions of immediate advance in instrumental construction and in specimen techniques. It was a timely decision of the Applied Physics Section of the Netherlands Physical Society to organise a conference in the subject at Delft, during July 4–9, with the active co-operation of the Electron Microscopy Group of the Institute of Physics, and of similar societies in France and Sweden. It was very much an international gathering, and the forty-five papers contributed were of a variety and quality that challenged comparison with the annual meetings of the Electron Microscope Society of America.

The development of the electron microscope is so far advanced that chief attention should now be given to improving specimen techniques, so as to exploit to the full its very high resolving power. The important task remains, however, of devising ready means by which the good average operator, with a commercially supplied instrument, may achieve the high performance which has been laboriously obtained on a few special machines in skilled hands. This is primarily a matter of eliminating astigmatism from the lenses, the only aberration for which correction is so far possible. The inherent astigmatism of electron lenses is so small as to be negligible in comparison with their spherical aberration, but a large amount may be introduced by mechanical defects of construction: by departure from circularity of bore, or exact alignment, of the pole-pieces (or of the electrodes, in electrostatic lenses), and by inhomogeneity of the iron in magnetic lenses. It is thus necessary to machine them to the highest degree of precision in the first place, and then to develop means of readily estimating and compensating the residual astigmatism; by this means the achieved resolving power may be reduced from 50 A. to below 20 A.[1]. P. A. Sturrock (Cavendish Laboratory, Cambridge) gave a mathematical analysis of the mechanical tolerances permissible in magnetic lenses, following the work of Bertein[2] on electrostatic systems, but making use of an elegant variant of Hamilton's method of characteristic functions. He showed that the accuracy required, less than 0·1 micron, was below that conceivably obtainable in practice or consistent with the degree of inhomogeneity to be expected in the material worked. J. B. Le Poole (Laboratory of Applied Physics, Delft) described a rapid means of examining electron lenses for astigmatism, using a hollow cone of illumination of relatively wide semi-angle to enhance the visible defect, and a means of correcting it by soft iron screws which could be manipulated without breaking vacuum. It is then possible to reach in less than an hour the same degree of correction that required two or three weeks in Hillier's original method[1]. The advantages of using current-carrying coils or electrostatic fields[2] for correction, instead of iron screws, were discussed by W. A. Le Rütte and Le Poole. P. Grivet, F. Bertein and E. Regenstreif (Lab. de la Cie. Gén. de T.S.F., and Lab. de Radioélectricité, University of Paris) described a method of investigating the astigmatism of an electrostatic objective, employing it as intermediate lens in a

three-stage microscope, so that the trajectories are such as to give enhanced astigmatism, in a pattern which is enlarged sufficiently by the projector lens to be visible in the photographed image. They described a first attempt at analysis of the aberration patterns so obtained, by which particular forms might be related to different mechanical defects of the lens. The general impression given by these discussions was that very soon makers would be able to supply microscopes with lenses corrected for astigmatism, which could be readily tested at any later time and re-corrected if need be.

The more general problem of measuring lens errors, and especially spherical aberration, received some attention. G. Liebmann (A.E.I. Research Laboratories, Aldermaston) described the use of a resistance network in place of an electrolytic tank to trace field distributions[3], by which a very high order of accuracy may be achieved. The degree of spherical aberration is obtained from the computation of typical trajectories, or alternatively it may be directly observed in an experimental tube with movable viewing screen. In principle, it is possible to calculate the aberration figure in the image or any other plane, once the form of the lens field is known, without tracing paths right through the lens. A. Maréchal (Institut d'Optique, Paris) described a machine for carrying out the necessary integrations very rapidly[4]; it can be employed for electron lenses as well as for optical lenses. By means of specially cut cams, shaped according to the field distribution, the aberration figures can be drawn for individual or combined errors, of the fifth as well as the third order. It should be of great help in the search for fields of low aberration.

The resolving power of the electron microscope has so far been defined in terms of the Abbe model of optics: the least separation of two point objects at which they are distinguishable in the image. Mr. M. E. Haine (A.E.I. Research Laboratories, Aldermaston), in the course of a survey of problems of resolution, gave reasons for abandoning this classical method in favour of one based on the half-width of the image of a single object point, or the width of the Fresnel fringes of a half-plane. The chief reason is the absence in electron microscopy of any suitable test object having features separated by distances of the order required (10–50 A.) comparable with the test diatoms of optical microscopy. At such high resolutions, approaching molecular dimensions, the question of resolving power cannot be separated from that of contrast, the second limiting factor on visibility. E. G. Ramberg (R.C.A. Research Laboratories, Princeton, N.J.) discussed the latter in terms of the scattering cross-section of different atoms for varying apertures of illumination. The interesting result emerges that the cross-section (and hence the image contrast), although dependent on atomic number in absolute value, is for nearly all substances approximately constant over the range of illuminating aperture employable in practice (10^{-3} to 10^{-2} radian) within the limitations set by spherical aberration and diffraction. Some gain in contrast may be obtained by using a physical aperture equivalent to 10^{-2}, rather than none at all, since the cross-section rises rapidly with reduction in angle in this region. But little further gain results until the aperture is made very small (10^{-3}), when loss of resolving power is incurred by diffraction. With biological material of low inherent contrast, however, it may be desirable to sacrifice some resolution in favour of contrast, as Hillier has recently pointed out[5]. Ramberg also discussed the contribution made by phase-contrast effects to the visibility of the image, arising from the differing inner potential of parts of the object. This becomes appreciable in thin objects at high resolution. Experiments designed to obtain true phase-contrast images in the electron microscope were described by A. W. Agar, R. S. M. Revell and R. A. Scott (Research Dept., Metropolitan-Vickers Electrical Co., Ltd., Manchester). Preliminary work has so far yielded no definite result.

The electron microscope of present type having been carried almost to its theoretical limits of resolution, the task now is to find means of circumventing the obstacle set by spherical aberration of the lenses. Scherzer[6] has summarized the means which have been variously proposed for developing new types of lenses of zero aberration; these involve asymmetrical construction, controlled use of space charge, or very high frequency fields, and are all beset with great practical difficulties. D. Gabor has devised an elegant method of 'diffraction microscopy'[7] which was described to the Conference. The preliminary optical trials are very convincing, and the electron optical tests are awaited with great interest.

Meanwhile, the problem of refining specimen techniques is receiving great attention. It is a matter of so preparing each type of object that its relevant details are laid bare in the electron micrograph. Most specimens have inherent limitations which impair the resolution obtained, owing to lack of contrast, excessive thickness, or difficulty of dispersion, for example. A. J. A. Nieuwenhuys (Laboratory for Applied Physics, Delft) gave a critical survey of shadow-casting methods, by which contrast is enhanced by oblique deposition of metals. Conditions can now be established which minimize the danger of artefacts caused by aggregation of the deposited metal. L. H. Bretschneider (Zoological Laboratory, Utrecht) described a method of adapting the Cambridge rocker microtome to cut sections of biological material sufficiently thin ($< 0{\cdot}3$ micron) for electron microscopical examination[8]. The preliminary results were encouraging, and supported the evidence of others[9] that the conventional microtome can be refined to meet these new demands, avoiding the expense and complexity of the very high-speed microtomes which have been alternatively devised.

The examination of surfaces requires the making of a replica sufficiently thin to be penetrated by the electron beam, and much remains to be done in improving both the resolution obtainable in this technique and the range of its applicability. J. Nutting (Cavendish Laboratory, Cambridge) described a method of taking replicas from metal wires, which allows the effect of drawing down to be investigated. E. Kellenberger (Institut de Physique, University of Geneva) described a new type of silica replica process for biological objects, which showed good detail and contrast from bacteria[10]. W. W. Varossieau (Forest Products Laboratory, Delft) described the application of a three-stage replica method due to Nieuwenhuys to the study of wood anatomy. Remarkably clear photographs were shown from different woods, and from specimens which had suffered decay or damage. The interpretation is still in a preliminary stage, owing to the wealth of detail revealed, as compared with optical microscopy.

Papers on applications of the electron microscope, equal in number to the work already described, showed how widely the instrument is now being used

in pure and applied research. The majority were on biological topics, a surprisingly large number on chemical and industrial applications, and only a few on metallurgy. This last group, however, was of high quality and indicated that replica techniques are now so far mastered as to open up great possibilities for metallurgists. P. Coheur and C. Habraken (Centre Nat. Rech. Métallurgiques, Liège) showed interesting but unexplained effects occurring during creep in steels; and R. Castaing (Office Nat. de Rech. Aéronautiques, Paris) exhibited some beautiful oxide replicas showing the shape and orientation of newly formed Al_2Cu crystals in the first stages of age-hardening of aluminium copper alloys[11]. In the same field of work, Castaing and A. Guinier described an ingenious scanning method of metallurgical analysis, in which an electron spot less than 1 micron in diameter is moved about a metal surface, and the emitted X-rays analysed, in order to find the small-scale variations in chemical composition of the surface.

In the biological field the most important papers were probably two from the United States and Sweden. E. de Robertis (M.I.T., Boston) described his recent work on the structure of the nerve axon, which proves to contain a mass of 'neuro-tubules', cross-banded like the larger fibres. On infection with poliomyelitis virus, the progress of dense particles along the axon can be followed in periodically isolated samples. F. Sjöstrand (M.I.T., and Karolinska Institute, Stockholm) described membrane structures found in the retinal rods of the guinea pig eye and in nerve tissue. These consist of rounded disks, some of which are as thin as 70–80 A. at the edge, decreasing to 30 A. at the centre. These are believed to be the unit structures of the rod outer segment. Membranes of about the same thickness were isolated also from peripheral nerve tissue; they may derive from the myelin sheath. The occurrence of a thin membrane, or epicuticle, in wool and other animal fibres was demonstrated by B. Philip and G. Lagermalm (Institute for Textile Research, Göteborg).

The work on viruses continues to increase in quality as well as extent, as shown in three papers. In bacteriology, two interesting contributions on the flagella and sub-flagella of various species were read by Miss W. van Iterson and A. L. Houwink (Laboratory for Microbiology, Delft)[12]. The remaining papers ranged from a study of the ageing of human skin to that of the nuclear apparatus of bacteria, of the membrane of myxomycete spores and of tissue-cultured sarcoma. The chemical applications, which cannot be particularized, showed the increasing use of the electron microscope in industrial laboratories.

Papers were also presented on constructional improvements in the instrument, and related apparatus. Most interesting was a combined electron diffraction camera and microscope, due to M. v. Ments and Le Poole, having the great merit that the pattern dimensions are independent of object position and voltage fluctuation over an appreciable range. This promises to add greatly to the precision of electron diffraction work, especially by the reflexion method. It was demonstrated during the course of the Conference, as was the new Philips electron microscope and those built in the Delft Laboratory. W. A. Le Rütte showed an electrostatic microscope that employs an electron mirror as projector, giving a conveniently placed image with no distortion.

All in all, the Conference witnessed to the rapid progress made in Europe since the War in electron microscopy in all its aspects, theoretical as well as practical.

V. E. COSSLETT

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[2] Bertein, F., *C.R. Acad. Sci.*, **224**, 106, 560 (1947); **225**, 801 (1947).
[3] Liebmann, G., *Nature*, **164**, 149 (1949).
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[6] Scherzer, O., *Optik*, **2**, 114 (1947); *J. Appl. Phys.*, **20**, 20 (1949).
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[8] Bretschneider, L. H., *Proc. Kon. Ned. Acad. Wet.* (in the press).
[9] Baker, R. F., and Pease, D. C., *J. Appl. Phys.*, **20**, 480 (1949); Claude, A., Harvey Lectures (1947–48) (in publication).
[10] Kellenberger, E., *Experientia*, **4**, 449 (1948).
[11] Castaing, R., *C.R. Acad. Sci.*, **228**, 1341 (1949).
[12] van Iterson, W., and Houwink, A. L., *Biochim. Biophys. Acta* (in the press).

SCIENTIFIC RESEARCH IN THE UNIVERSITY OF BIRMINGHAM

THE nineteenth annual report of the Joint Standing Committee for Research of the University of Birmingham, covering the session 1947–48, makes a valuable contribution towards completing the general picture of Great Britain's research effort which is demanded as a basis for any re-orientation. The immediate funds for research available to this Committee are very modest, giving an income of only £839 for the session, but are now supplemented by grants from the University's general funds. The report details the conditions and procedure for applications for grants, and besides a classified list of research publications during the session, it includes a summary of researches completed during the session 1947–48, and reports on experimental cancer research at the Cancer Research Laboratories of the Medical School, financed by the Birmingham Branch of the British Empire Cancer Campaign and from the Radiotherapy Department of the United Birmingham Hospitals. Only a few of the researches completed during the year can be noted here.

In the Department of Mathematical Physics, the study of nuclear forces led to a method for treating the scattering of fast neutrons by protons. In the Department of Physics, besides cyclotron work in nuclear physics, work has been done on the optical absorption of crystal defects and impurity atoms in phosphor lattices, and on the dielectric strength of liquids for short pulses of voltage; assays have been made of the content of radioactive zinc in biological specimens. The Department of Chemistry has carried out investigations on polymeric carbohydrates as substitutes for blood plasma, and has completed work on pneumococcus and mycobacterium tuberculosis polysaccharides which have a potential value as vaccines; work on fluorine chemistry has yielded a new range of organic fluorine compounds, some of which are of potential interest as non-inflammable lubricants, plastics, insulating materials, etc.

Work in the Department of Zoology on the nature and mechanism of tissue transplantation, immunity in animals, on the endogenous origin of virus-like bodies responsible for natural skin pigmentation in mammals and on the water relations of terrestrial isopods has progressed. In the Department of Botany, the effect of pretreatment of storage tissue on subsequent salt absorption, the salt relations of plant tissue and the biology of *Phytophthora Fragariæ* in relation to red core disease of strawberries have been studied.

The Department of Mechanical Engineering completed the first stage of an investigation of the

processes accompanying the sudden discharge of compressed gas from a cylinder into a pipe system. Creep and shrinkage phenomena in plain and reinforced concrete beams and columns and the use of light alloys for large structures were studied in the Department of Civil Engineering; while in the Department of Electrical Engineering the interaction of radio waves in the atmosphere, the motions of slow electrons in gases and the electrical properties of fluoro-carbons were investigated. The Department of Chemical Engineering reports preliminary investigations into the chemical nature of the resins and the 'free carbon' of coal tar, and studies of the vapour–liquid and liquid–liquid relations of the system acetic acid–water–ethyl acetate. Long-term programmes on the theory of the constitution of alloys and on the deformation of metals and alloys were developed in the Department of Physical and Theoretical Metallurgy, and in that of Industrial Metallurgy investigations on the welding of aluminium alloys, the melting, casting and fabrication of copper–tin alloys and the effect of chemical composition, etc., on the crystal orientation and magnetic permeability of 3 per cent silicon steels were completed.

AMERICAN PHILOSOPHICAL SOCIETY

RESEARCH REPORTS

THE Yearbook for 1948 of the American Philosophical Society, in addition to the usual reports of standing committees, auditor's reports, lists of lectures and publications, awards of prizes and research grants, biographical memoirs, etc., includes classified reports from the recipients of grants. The report of the Committee on Research details the general principles adopted by the Committee for determining the awarding of grants.

Among the reports from recipients of grants may be mentioned those from H. N. Russell on his work on behalf of the panel on orbits of eclipsing variables, which has led to the selection of thirty-five eclipsing systems for a first catalogue of eclipsing binary systems, from W. J. Luytens on the measurement of the proper motions of stars in the southern hemisphere north of declination −40°, H. H. Nininger on a magnetometer search for meteorites at Barringer Meteorite Crater, and W. J. Moore on his investigation of properties of the simpler aliphatic free radicals in the gas phase and in solution.

D. P. Costello reports on natural and induced heteroploidy in *Triturus torosus* and *Triturus rivularis*, two species of California salamanders; R. Rugh on a study of cortical changes in the egg of the frog, *Rana pipiens*, following fertilization; D. C. Smith on studies on the thyroid gland of fishes; W. D. McElroy on factors influencing the response of the bioluminescent reaction to adenosine triphosphate; H. Geiringer on the mathematics of heredity; and R. S. Palmer on an investigation of mammalian ecology and populations in the upper Allagash region of Maine. Cytogenetic studies of the lethal *E* complex, particularly as it affects a temporary reversion of *Neurospora tetrasperma* to an eight-spored *N. sitophila* type, are described by B. O. Dodge; a study of post-glacial forest migrations and climate in Western Canada by H. P. Hansen; cytogenetic studies on the guayule rubber plant and related species of *Parthenium* by R. C. Rollins and a survey of the algæ and economic algal resources of the Philippines by G. T. Velasquez. T. C. Schneirla summarizes his studies on army-ant behaviour and its biological basis; S. Wapner those on equivalence of stimuli and transportation in the rat; J. L. and E. M. Irvin their work on the interaction of certain antimalarial compounds with typical proteins and nucleic acids. F. Machlup describes his analysis of the economics of the patent system.

L. S. Cressman discusses his work on the archæology of the Klamath Indian culture of Oregon and its position in the Northern Great Basin Culture. Continued excavation of prehistoric remains in western Colorado is described by C. T. Hurst, an archæological, botanical and geological expedition to the Southwestern Yukon in 1948 by F. Johnson, and archæological investigations in southern Ontario, Canada, in search of the earlier stages of the Owasco culture, by W. A. Ritchie.

GEOGRAPHY OF THE ANCIENT WORLD

IN a series of papers published between 1944 and 1948, Prof. E. Stechow, of Munich, seeks to show that a much larger area of the world's surface was known in antiquity than is commonly supposed. His conclusions are based on a re-reading of passages in ancient authors, and some points deserve serious consideration. Prof. Stechow identifies "Iambulus Island" of Diodorus Siculus II, 55 ff. with Madagascar[1]. The astronomical and navigational data fit suggestions made by R. Hennig[2]; and the "vertical writing" of Diodorus's account would vouch for the Malay–Madagascar contact a thousand years earlier than the report of the Arab geographers. Stechow explains the reference to "seven islands" as an error due to the configuration of the Madagascar coast-line.

It is argued[3] that Hanno, whose expedition is dated by Prof. Stechow to 537–525 B.C., did not turn back until reaching Mount Cameroon (which is described in a state of eruption), and that he met real gorillas, not baboons, chimpanzees or pygmies. Stechow postulates lacunæ in the Greek translation to explain the small number of days for the journey; the references to native drums, other details and a navigational point in Arrian all suggest that Hanno went beyond Mt. Kukulima (Sierra Leone) into an area 1° N.

Prof. Stechow contends[4] that in the Sixth Dynasty the Egyptians knew of the pygmies and the okapi of the Congo forests and, in the Eighteenth, of the greater Nile marshes. He believes that two of the four "Pillars" in the inscription of Ramses II are Ruwenzori and Mt. Cameroon. More fanciful are his identification of Ophir with Zimbabwe, Rhodesia, and his speculations on an Egyptian element in the Hottentot peoples.

Prof. Stechow interprets[5] Pliny "Natural History", IV, 96/7 as referring to the mouth of the Oder, Cylipenus as the Bay of Stettin, Tastris peninsula as Ruegen, etc.

J. G. GRIFFITH

[1] *Petermanns Geog. Mitt.*, **90**, 84–5.

[2] Hennig, R., in "Terrae Incognitae" (**1**, 391 ff, second edition) admits a "certain possibility" in this view. Contrast, however, J. O. Thomson, "History of Geography", pp. 274, 281 (no reference to Diodorus.

[3] *Forschungen und Fortschritte*, **21–23** (July 1947) and **24** (July 1948).

[4] *Petermanns Geog. Mitt.*, Heft 3–4, 181 (1948).

[5] *Forschungen und Fortschritte*, **24** (Oct. 1948).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Diffraction Analysis of a Photograph of the Sea

It is well known that diffraction can produce the amplitude spectrum of a two-dimensional pattern[1]. The aerial photograph of the sea shown in Fig. 1 has been examined in this way. In the form of a transparency (a lantern slide) it was used to cover a lens of focal length 1 metre which was illuminated by the light from a sodium lamp behind a pinhole 2 metres away. The lens alone gave a sharp image of the pinhole; but when the lens was covered by the transparent photograph, the image took the form shown in Fig. 2. These pictures were obtained by direct photography of the image upon panchromatic film, and have been reproduced at their actual size.

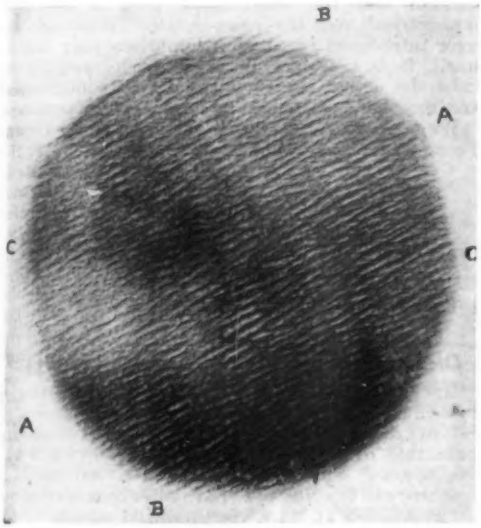
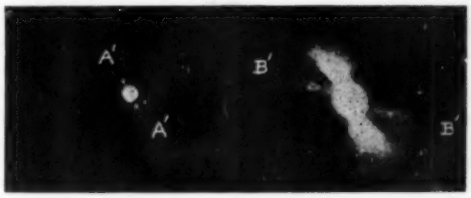


Fig. 1

Fig. 2*a* is the result of one minute exposure; the central image is over-exposed, but two small diffraction images $A'A'$ are visible. These are due to diffraction by the main system of waves in the photograph, the crests of which are approximately parallel to a line A_1A_1. An exposure of twenty minutes gives the image shown in Fig. 2*b*. The spots $A'A'$ are now over-exposed and have merged into the central image, but the fainter parts of the image now appear. A cone of light extends outwards from each spot $A'A'$, showing that the wave system in the photograph includes wave trains with crests approximately parallel to AA and which have a great variety of wave-lengths all less than that of the main wave system.

The image 2*b* shows two faint traces $B'B'$, indicating that there is a wave system in the photograph having its crests parallel to BB (where BB is perpendicular to $B'B'$). There is a variety of wave-lengths in this system, but the most intense parts of the traces $B'B'$ are nearly three times as far apart as the points $A'A'$,



(*a*) (*b*)

Fig. 2

indicating a wave-length about one-third the length of the main swell. The wave system BB can be seen in the original photograph.

The original photograph also shows a faint wave system of short wave-length with crests approximately parallel to CC. The image 2*b* does not distinguish this system; its diffraction image may have merged with the shorter components in system AA and helped to produce the obvious asymmetry in the $A'A'$ image in Fig. 2*b*.

The diffraction process therefore gives a convenient summary of the various periodicities in the photograph. Although no periodicities have been revealed that could not be seen on the original photograph, the analysis shows more clearly the range of wave-lengths and the range of wave directions inherent in each system. The sea is a particularly appropriate subject for this treatment; but it would also serve to record the periodicities visible in a mackerel sky or in the formation of desert dunes.

It is essential to use a photograph on glass, because of the bad optical qualities of celluloid film. It is desirable to 'vignette' the edges of the picture, since hard straight edges give rise to streaks radiating from the central spot of the image.

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[1] James, R. W., "The Optical Properties of the Diffraction of X-Rays" (Bell, 1948). Also, Schouten, J. F., "The Diffraction of Light by Sound Film", *Philips Tech. Rec.*, **3**, No. 10, 298 (October 1938).

High-Current Betatron Conditions

A simple theory has been developed which relates the flux linking the stable orbit to the guiding magnetic field at the orbit for the general case of a betatron in which the current of accelerated electrons is large.

The back e.m.f. due to circulating currents of this magnitude will be comparable to the e.m.f. induced by the external flux, and there will also be a weakening of the net guide field at the orbit owing to the field produced by the electron current.

The equation of motion of an electron can be represented by:

$$\frac{e}{2\pi r_a}\left(\frac{d\varphi}{dt} - L\frac{di}{dt}\right) = \frac{d}{dt}(mv), \qquad (1)$$

where

$$m = m_0(1 - \alpha^2)^{-1/2} \qquad (2)$$

and $\alpha = v/c$, v is velocity of the electron, e is charge on the electron (e.m.u.), m_0 is rest mass of the electron, c is velocity of light, r_a is radius of the stable orbit, φ is flux linking the stable orbit and produced by the betatron coils, L is inductance of the single toroidal turn formed by the 'doughnut', and i is the circulating electron current.

From this equation we have deduced the relation :

$$\varphi = 2\pi r_a \frac{m_0}{e} c\,(1 - \alpha^2)^{-1/2}\,\alpha + AneLc\alpha, \qquad (3)$$

in which $$i = Anev, \qquad (4)$$

where A is cross-sectional area of 'doughnut', n is number of electrons per c.c. that have initial velocities within the range of magnitude and direction in which capture into a stable orbit will be possible.

The external guide field required for any value of α can be calculated from the relation

$$mv = eH_n r_a, \qquad (5)$$

in which the net guide field H_n is given by

$$H_n = H - Ki, \qquad (6)$$

where H is the externally produced guide field, and Ki is the opposing field due to the electron current i.

Three cases may be considered : (*a*) n small, (*b*) n large, (*c*) n of intermediate value.

(*a*) *For small values of n :* ($n < 10^8$ for a betatron with $r_a = 15$ cm. and diameter of cross-section of 'doughnut' = 5 cm.). The second term in (3) is negligible compared to the first for all values of α, so that

$$\varphi = 2\pi r_a^2 H_n = 2\pi r_a^2 H, \qquad (7)$$

since $H \gg Ki$ for n small. This is the usual betatron relation.

(*b*) *For large values of n :* ($n > 10^{13}$ in the above case). The first term in (3) is negligible compared to the second for $0 < \alpha < 0{\cdot}9$, so that

$$\varphi = AneLc\alpha. \qquad (8)$$

This gives a linear relation between φ and H only for small values of α.

For small α, ($m \simeq m_0$), we obtain

$$\varphi = \left(\frac{Ane^2Lr_a}{m_0 + KAne^2r_a}\right) H. \qquad (9)$$

In general, however, φ and H are related by the non-linear equation

$$\left(H - \frac{K}{L}\varphi\right)^2 [1 - \varphi^2/(AneLc)^2] = (m_0/er_a)^2. \qquad (10)$$

(*c*) *For intermediate values of n :* ($10^8 < n < 10^{13}$ in the above case). Both terms in (3) must be taken into account.

Here again a linear betatron condition is obtained at non-relativistic velocities.

For small α we obtain

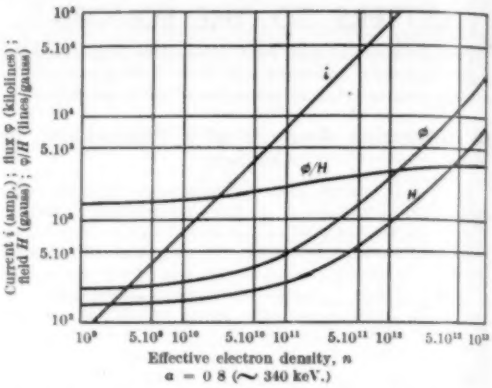
$$\varphi = \left(\frac{2\pi r_a^2 m_0 + Ane^2Lr_a}{m_0 + KAne^2r_a}\right) H. \qquad (11)$$

In the general case of intermediate n and any α, graphical methods have to be used to find φ in terms of H. We find that for the electron velocities in which we are interested ($\alpha < 0{\cdot}9$) the departure from linearity is never very large.

Curves showing the variation of the electron current i, the externally produced flux and guide field φ and H, and the ratio φ/H, with the effective electron density n, are reproduced herewith.

It should be noted that it is possible to derive from (3) and (4) the variation of electron current with time, provided the variation of the externally produced flux φ with time is also known.

If the electron current produced is appreciable, the betatron must be treated as a loaded transformer, so that the reflected secondary impedance must be taken into account in calculating the primary impedance.



In the above analysis the effects of space charge are assumed to be negligible. This would be the case if the distribution of electron current density is uniform and the electrostatic field is circularly symmetrical over the cross-section. Although the error introduced by these assumptions may not be small, it is necessary to make such assumptions until the actual electromagnetic field configuration and the charge distribution have been determined.

We wish to express our indebtedness to Sir George Thomson for suggesting this problem.

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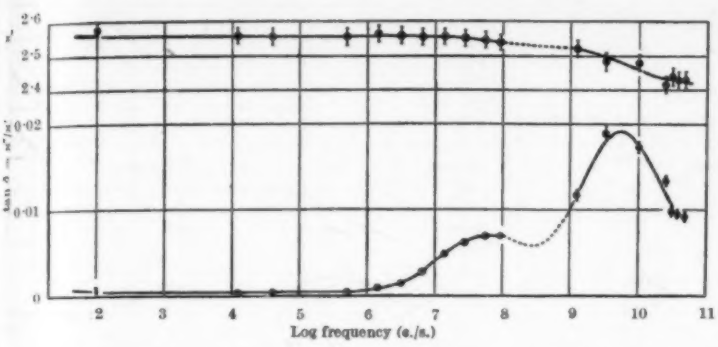
Dielectric Behaviour of Methyl Palmitate

An earlier letter[1] gave the results of a series of measurements of the complex permittivity $\varkappa = \varkappa' - j\varkappa''$ at room temperature of a sample of methyl palmitate over the frequency range $50 - 3 \times 10^6$ cycles/sec. Further measurements, extended in frequency to 5×10^{10} c./s., have since been carried out at $20{\cdot}8 \pm 0{\cdot}3°$ C. on a recrystallized sample of the same material, with the results shown in the figure. These differ from those previously reported in the virtual disappearance (*a*) of dielectric loss at the low-frequency end of the spectrum, due presumably to the complete removal of ionic impurity and moisture in this case, and (*b*) of a dip in the permittivity curve at the $3{\cdot}16 \times 10^9$ c./s. point, which resulted from an obscure error in the measurement at this frequency and which led us to suggest the possibility of a resonance phenomenon. The form of the tan δ variation remains substantially as shown in the earlier publication. Notwithstanding the lack, as yet, of measurements between 10^6 and 10^9 c./s., there would seem to be no doubt of the existence of two separate absorption regions centred close to 10^9 and 10^{10} c./s. respectively. This is an interesting occurrence and is being further studied at variable temperature.

The permittivity curve lies somewhat higher than before, in consequence of the use in these later measurements of compressed powder specimens, of density 0·997–0·984, within two per cent of the crystal density, instead of moulded ones.



I wish to thank the staff of the Electrical Research Association for their assistance in preparing the purified material to which the present measurements relate, and Dr. J. A. Saxton, of the Department of Scientific and Industrial Research, for the measurement at 5×10^{10} c./s.

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Aug. 1.

[1] Dryden, J. S., and Jackson, W., *Nature*, **162**, 656 (1948).

An Interference Paradox in Sound

ONE of the commonest demonstrations of interference is that between two loud-speakers actuated by separate audio-frequency oscillators. When the two oscillators differ slightly in pitch, the audience perceives beats which form a complicated pattern of interferences in the room. At any point in the room there is a probability of $\frac{1}{2}$ that the phase difference of waves coming from the two sources lies between π and 2π, consequently that the sound-level may be less than that due to one source alone, a fact that is readily demonstrated with a microphone.

This conclusion could be extended to cover any case of two sources in consonance, for example, to two violins playing in unison. Put in the form of this paradox: "Do two violins make more sound than one alone?", the question may give rise to confusion in the minds of those who favour a negative answer on the basis of the theory of interference, as it is usually taught, yet whose experience is at variance with such a conclusion. Anyway, if the two violins are not exactly in unison, beats should be heard which should be perceived by the ear, even if the ear is not sensitive to local variations in sound-level.

I suggest that in addition to obvious causes such as the sources not being points or remaining stationary, other causes operate to make two violins always sound louder than one:

(1) Slight variations of the pitch of each violin round about their nominal value occur. Besides the inability of a player to hold an instrument in precise intonation due to human failing, oscillograph records of the sounds of a violin show objective changes of pitch with the tension, which tends to decrease, especially after pizzicati, as the strings relax. This is most marked with catgut but still noticeable with metal strings, the repeated stresses leading to relaxation of the pegs in their holes and a drop in frequency which may amount to 2 per cent. Besides this shift, the frequency of each violin varies in random fashion under various influences, especially the pressure of the bow.

(2) The customary vibrato playing itself modifies continuously both the frequency and amplitude of the note, thus preventing the ear from perceiving regular beats between the two violins.

Experiment shows that the complex note produced by each instrument gives rise in an extended medium to a resultant note still more complex, the amplitude of which varies in a scarcely perceptible fashion by not more than a few decibels. Any notion of rhythm in these variations, so important for the clear perception of beats, is completely wanting. Sometimes at low frequencies, however, a series of five or six successive beats may be heard.

(3) In a room another phenomenon is superposed. According to a theorem of Rayleigh, when an increasing number of waves from sources of random phase distribution are superposed, the pressure amplitude increases as the square root of their number, approximately, a case which should apply to an orchestra. When there are two sources only, one must still consider their acoustic 'images' formed in the walls of the room, so that the effect at any point in the room may still be regarded as that of a number of sources of random phase distribution. In practice, due to absorption, only the reflexions in the walls of first orders need be considered.

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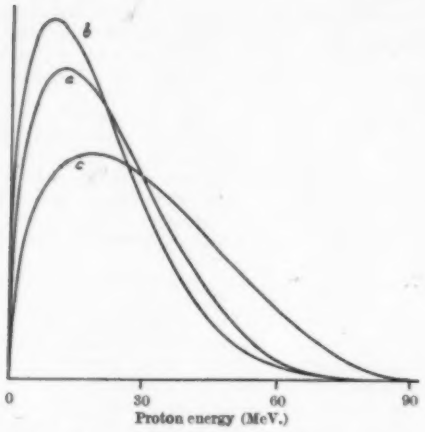
Disintegration of Helium by Π^- Mesons

MANY estimates have been made of cross-sections for meson capture; but apparently the resulting nuclear disintegrations have seldom been treated. Observations on the energies of the emitted particles might give some information on the interaction between mesons and nucleons and would show whether a neutral meson is produced or the whole meson mass is absorbed. Experimental results could be interpreted without ambiguity only in the case of very light elements. Helium is the lightest element to emit a charged particle and might be used in experiments with artificially produced mesons.

We have calculated the energy spectra and relative probabilities of the three ways of disintegration of helium-4 on the following assumptions: the meson is captured from the lowest Bohr orbit; the whole mass (290 electron masses) is converted into energy; the interaction energies are (*a*) $\psi(r)$ or (*b*) $\sigma.\nabla\psi(r)$, where $\psi(r)$ is the scalar meson wave function at the position of a proton and σ is the spin operator of the proton. Gaussian wave functions ($\exp(-\alpha\Sigma r_q^2)$, $1/\sqrt{\alpha} = 4{\cdot}0 \times 10^{-13}$ cm.) are used for the nuclei and plane waves for the emitted particles. The transition probabilities are determined by the usual perturbation method.



We find that the relative probabilities for emission of a triton, deuteron or proton are

5 : 1 : 5 with interaction (*a*),
or 12 : 1 : 25 with interaction (*b*).

Only one energy (30 MeV.) is possible for the triton if the meson is completely absorbed; but, if a neutral meson is formed, a spectrum of energies will be observed. An experiment would distinguish these cases directly. The probability of deuteron emission is rather small and is reduced further if the value of α in the deuteron wave function is reduced (corresponding to large radius).

The normalized energy spectra of the protons are shown in the accompanying figure: (*a*) using interaction $\psi(r)$; (*b*) using interaction $\sigma.\nabla\psi(r)$; (*c*) using a matrix element independent of the energies of the emitted particles.

Variation of the parameter α in the nuclear wave functions does not greatly affect our results.

We wish to thank Prof. H. Fröhlich for much helpful advice.

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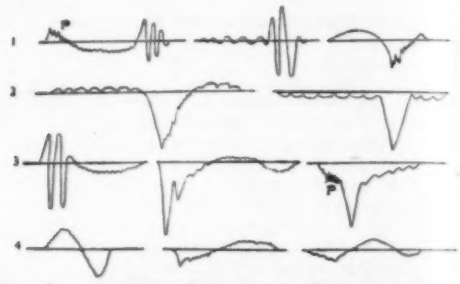
Low-Frequency Components of Atmospheric Pulses and their Origin

THE work of Appleton and Chapman[1] has shown that when the source of atmospheric disturbance is at a distance of about 200 km., an aperiodic or quasi-periodic pulse which represents the high-frqeuency component is usually followed by a slow component. In our recent experimental study of the wave-forms of atmospherics carried out at Dacca, we have been able to obtain oscillographic records showing (i) a slow component *ahead of* the aperiodic or quasi-periodic pulse, and (ii) slow components on *either side* of the high-frequency group in addition to the records showing a slow component following the high-frequency component. In a few oscillograms two or three half cycles of very slow components with a range of frequencies between 130 and 1,265 cycles/sec. have been observed. The object of the present note is to report these observations and to suggest interpretations as to their origin. These observations were made in addition to the usual aperiodic and quasi-periodic pulses, the aperiodic or quasi-periodic pulse followed by a slow component, 'precursors' and 'repeater' pulses due to multiple reflexion between the earth and the ionosphere.

The equipment consisted of a long horizontal aerial, a resistance-capacity-coupled amplifier with constant voltage gain over a wide range of frequencies, and a cathode ray oscillograph with linear time-base. The observed wave-forms represented voltage variations across a suitable condenser placed in series with the aerial.



Wave-forms in different time-scales. 1. Slow component preceding the high-frequency group. *P*, 'precursor'. 2. Slow component on *either* side of the high-frequency group. 3. Slow component following the high-frequency group. *P*, 'precursor'. 4. Slow periodic pulse of average duration of 3·01 m.sec. per cycle

Traces of the oscillographic records representing the new observations are reproduced herewith. The average duration of the slow components associated with the aperiodic or quasi-periodic pulses and the same for the very slow periodic pulses per cycle, together with the average durations of the observed aperiodic and quasi-periodic pulses, precursors and superposed ripples are given in the accompanying table for comparison at a glance.

Impulses	Average duration (m.sec.)	Average frequency
Slow periodic pulses	3·01	323 c./sec.
Slow components	1·51	—
Aperiodics	1·71	—
Quasi-periodics	0·38	2·65 kc./s.
Precursors	0·11	8·95 kc./s.
Ripples	0·20	5·0 kc./s.

It is now known from photographic studies of lightning discharges[2] that a single lightning flash to earth is made up of a downward leader streamer followed by an upward return streamer of much quicker duration. The leader streamer brings negative charge into the air and distributes it over the conducting system, causing a slow change of electric field which corresponds to the *a*-stage of field-change observed by Appleton and Chapman. In the return stroke, there is an upward passage of positive streamers from the earth just before the arrival of one of the leader branches at the ground. This upward streamer advances very rapidly by drawing electrons produced by collision in front of its tip and passing them down via its conducting stem. There is a large and rapid change of electric field, and this is associated with the *b*-stage of Appleton and Chapman. The last portion of the return stroke, which involves the removal and passage down the channel of the residual charge on the cloud centre, is marked by a continuance of the channel luminosity after the return streamer has entered the cloud and is of com-

paratively longer duration. According to Schonland[3], this may be identified with the final slow field-change (the *c*-stage) of Appleton and Chapman, who also suggested the possibility of an upward discharge from the top of the thundercloud to the ionosphere as causing the slow change of field. Accepting the successive sequence of lightning discharges, it is evident that we should have slow components on either side of the aperiodic or quasi-periodic pulse which represents the high-frequency group at moderate distances from the discharge channel. It should be observed here that the high-frequency group has its origin in the first part of the return stroke, which is extremely rapid; this group is identified with Appleton and Chapman's *b*-stage of field-change and should lie between the slow components associated with the *a*- and *c*-stages of field-change. The oscillograms showing slow components ahead of the high-frequency group are also due to lightning discharges at moderate distances, and the slow component in these cases is to be attributed to the slow radiation field-change associated with the leader. It is to be noted that the slow pulse appearing before the quasi-periodic pulse which represents the high-frequency component is not due to the electrostatic effect of the slow field-change associated with the leader; for it is certain that, even at moderate distances, where the quasi-periodic pulse appears, the electrostatic field-change does not produce any perceptible effect. For longer distances, the slow component arising out of the leader would usually appear a little later than the high-frequency component due to the slightly higher group-velocity of the high-frequency group in dispersive transmission through the ionosphere. The slow component associated with the *c*-stage of field-change would, in any event, appear after the high-frequency component.

Regarding the origin of the slow periodic pulses of frequencies ranging from 130 to 1,265 cycles per sec., it may be suggested that they are due to electric impulses produced by the stoppage of meteors in the ionosphere. The suggestion is, however, not based on any experimental evidence.

A detailed paper on the subject will be published elsewhere.

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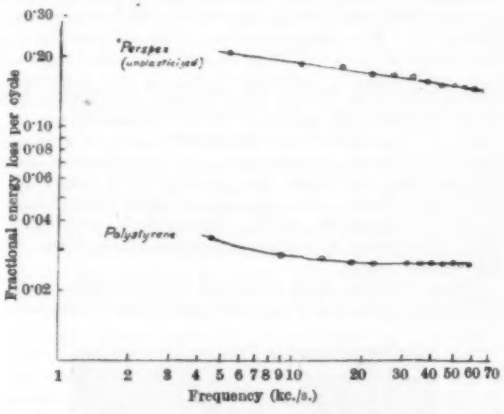
Energy Dissipation in Solids at Sonic and Ultra-sonic Frequencies

Previous experimental work on vibrating solid materials[1,2] has shown that, apart from the effects of certain well-defined relaxation phenomena, there is in addition, over a very wide range of materials, a fractional energy-loss per cycle which is sensibly independent of the vibration frequency. So far there has been little indication of the origin of this effect; but the results would seem to suggest that a hysteresis rather than a quasi-viscous or relaxation phenomenon is responsible, particularly as in general the temperature dependence is quite small.

An experimental investigation was started in 1947 at the Imperial College on such dissipative properties in certain high polymers in the glassy state. These may provide a convenient object of study because of their macroscopically homogeneous, though unordered, structure (reminiscent of the liquid state) and the possibility of examining the effect of variations in chemical constitution.

The experimental method finally adopted was to excite a rod of the test material into longitudinal resonance in its various harmonic modes. An iron disk cemented to one end of the rod enabled the vibrations to be excited by means of an electromagnet[1] or by an electrostatic traction plate[2], and a similar disk at the other end served as the moving electrode of a condenser microphone which was employed to measure the amplitude of vibrations. A frequency-range of about 5–60 kc./s. could be covered with a specimen 20 cm. long, the upper limit of the range being set by the smallness of the amplitude or flatness of response at the higher harmonics. Torsional and flexural vibrations could also be investigated on the same rod by the attachment of suitable small metal vanes to excite the appropriate vibration, care being necessary to eliminate spurious high-frequency resonances in the vanes themselves. The compact nature of the apparatus permitted it to be placed in an enclosure which could be evacuated when the effect of air damping was being investigated, and the whole system was contained in a constant-temperature bath.



So far, the amorphous polymers polymethyl methacrylate ('Perspex'), unplasticized and plasticized with 5 per cent dibutyl phthalate, and polystyrene have been examined at room temperature. In each case the fractional energy loss per cycle varied comparatively little with frequency (see graph). Young's modulus, too, was in each case almost constant (within 1–4 per cent), and equal to 5·6, 5·3 and $3{\cdot}7 \times 10^{10}$ dynes per sq.cm. respectively (at 5 kc./s.). 'Perspex' and polystyrene, which differ chemically in the nature of the side group on the main carbon chain, gave losses differing by a factor of about six; the presence of plasticizer in 'Perspex', however, caused little change in the loss. In polystyrene, the loss in torsional vibration was found to be equal, within experimental error, to that in longitudinal vibration, a result to be expected in a material for which the compressibility is small compared with the shear compliance, so that longitudinal vibrations mainly involve shear strains.

The magnitude of the energy loss in 'Perspex' was of a similar order to that obtained by Rinehart[3], but his finding of a loss increasing with frequency was not confirmed. Mason[4], observing free-wave 'infinite-medium' propagation, obtained attenuations in the case of polystyrene and 'Perspex' respectively 10 and 24 times greater than those corresponding to the loss figures at 60 kc./s. quoted for the same substances in the present experiments. This result is interesting, as it would seem to imply either a very wide variation of loss between different samples of the same material (although against this suggestion is the fact that a second specimen confirmed the loss figures of the first), or else a relatively high loss associated with the dilatational strains present in 'infinite-medium' propagation. It is hoped to investigate this question further using a common sample for the two types of propagation.

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Correlation of Internodal Length and Fibre Diameter in the Central Nervous System

There have recently been several reports of the presence of nodes of Ranvier in the central nervous system[1,2,3]. The demonstration of discontinuities in the myelin of isolated fibres is not sufficient to show that the sheath is interrupted in the living fibres; the myelin is so labile that breaks are frequently found in any preparation. It is characteristic of nodes of Ranvier in the peripheral nervous system that they occur rhythmically, at considerable distances along the fibre, the spacing being longer on the larger fibres[4]. It is possible to show that breaks in the myelin sheath, readily penetrable by methylene blue, also occur at regular intervals along fibres of the spinal cord.

Adult rabbits were injected intravenously with methylene blue, and the spinal cord fixed in ammonium molybdate and teased in glycerine. The stain was found to enter the fibres at specific points along the length, the myelin being here interrupted (Figs. 1, 2). The appearances were not always so definite as those of nodes in the peripheral nervous system; the myelin never retains its regular outline after isolation, probably because of the thinness or absence of a neurilemma. However, by carefully following the fibres, it can be shown that the breaks are spaced at intervals that are correlated with the diameter of the fibre (Fig. 3). The internodal distances varied

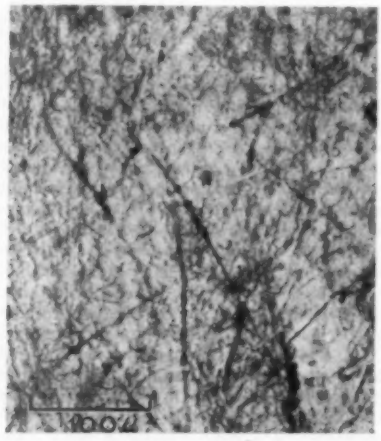

Fig. 1. Fibres of the spinal cord stained by methylene blue and separated in glycerine

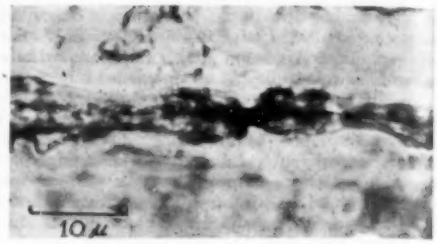

Fig. 2. Node on a fibre of the spinal cord stained by methylene blue and isolated in glycerine

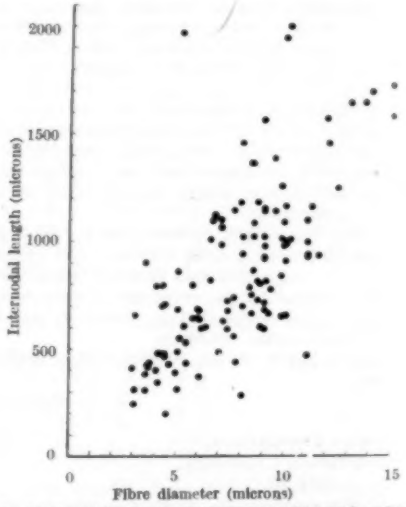

Fig. 3. Adult rabbit. Each point represents the length and total fibre diameter (axon and myelin) of a single internode

from 380 μ on a fibre of 3 μ to 1720 μ on one of 15 μ in total diameter, and the measurements show approximately a linear relationship between diameter and internodal length. Sometimes lengths were found to be twice or half of those expected on this hypothesis—as is also the case in peripheral nerve[4]—due presumably to obliteration of a node or formation of an extra one. Such irregularities are perhaps rather more frequent on the central fibres.

These facts suggest strongly that the myelin of these central fibres, taken mostly from the white matter of the ventral part of the spinal cord, is interrupted at regular intervals. No fibre which could be followed for a sufficient distance was found to be without such points of darker staining with methylene blue. There is, therefore, sufficient justification for supposing that some, if not all, central, like peripheral, fibres carry points at which the dye more

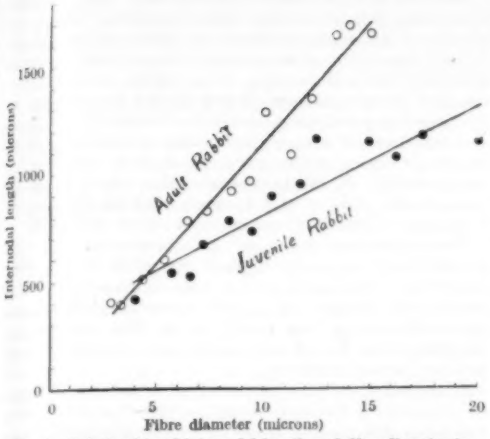

Fig. 4. Relationship of internodal length and fibre diameter in juvenile and adult rabbits. The points are the mean internodal length for each micron of fibre diameter

readily enters and at which, therefore, entrance and exit of other substances is presumably easier than elsewhere. These regions may reasonably be called nodes, even if they do not exactly resemble those of peripheral nerve fibres.

It is not yet possible to say what determines the periodicity of these central nodes; but measurements on two young rabbits showed the interruptions to be spaced less far apart than in adults (Fig. 4). It is therefore probable that, as in peripheral nerves, the details of the spacing depend on such factors as time of medullation and subsequent growth. Although the functional significance of the actual distances of spacing is not yet clear, it seems probable that the presence of these breaks in the myelin is significant for conduction in central as in peripheral nerve fibres[5].

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Elastase and Elastase-Inhibitor

We have reported in earlier communications[1,2] that the extract of fresh pancreas as well as that of acetone-dried pancreas powder contains a specific enzyme which we called 'elastase'. This enzyme had not been found before in the human or animal organism; but it was studied first by Eijkman[3] so early as 1904 as a product of bacteria. The elastase of the pancreas dissolves the elastic fibres of the arteries. We found that in the wall of the arteries only the elastic fibres are attacked by this ferment, and the collagen remains unaltered. We have been able to show that our pure elastase differs from other proteolytic ferments of the pancreas such as trypsin and chymotrypsin. Through the kindness of Dr. J. H. Northrop, of Princeton, N.J., we obtained crystalline trypsin and chymotrypsin, and we tested the elastolytic power of these enzymes parallel with our elastase. Neither trypsin nor chymostrypsin exercises any dissolving effect upon the elastic fibres of the arteries; therefore, we can conclude that the elastase is not identical with the known proteolytic enzymes.

In further experiments we found that human, rabbit and cattle blood sera possess inhibitory effects upon the elastolytic activity of elastase. The elastase-inhibitor is not identical with the trypsin-inhibitor described by Kunitz and Northrop[4], or with the plasma trypsin-inhibitor described by Schmitz[5]. Elastase-inhibitor cannot be purified, but it is destroyed by treating it with 2·5 per cent trichloracetic acid, whereas trypsin-inhibitor can be purified in this way. Elastase and elastase-inhibitor form a compound. The law of *Reihenfolge Phänomen* is valid in the interaction of elastin, elastase and inhibitor. In the blood of men suffering from arteriosclerosis, the quantity of elastase-inhibitor is either decreased or it has disappeared entirely.

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Paralysing Activity of Some Heterocyclic Decamethylene-αω-*bis* Quaternary Ammonium Salts

The work of Barlow and Ing and of Paton and Zaimis, recently reviewed by Paton[1], has established that the distance separating a pair of quaternary nitrogen atoms corresponding to optimal paralysing activity for mammals approximates to that occupied by the decamethylene chain. The present work was undertaken with the object of investigating the effect of varying the groups attached to a pair of quaternary nitrogen atoms, separated by a decamethylene chain, upon paralysing and associated activity. In modifying the groups attached to these quaternary nitrogen atoms, we aimed at simulating various chemical features of the tubocurarine molecule.

The substances synthesized are shown in Table 1. Substances 1, 3, 5, 7, 9 and 11 were prepared by refluxing excess of the corresponding tertiary amine with decamethylene dihalide in benzene solution. The remaining compounds were prepared by refluxing excess of the corresponding secondary amine with decamethylene dihalide in benzene solution and treating the resulting tertiary amine with methyl iodide.

All compounds were submitted to a preliminary test in mice for intravenous toxicity and of paralysing activity, using the rotating drum technique described elsewhere[2]. The results of these tests, expressed as the customary fifty per cent lethal and paralysing doses (LD 50 and ED 50), are summarized in Table 1.

In view of the well-established fact that mammalian species may differ considerably in their sensitiveness to any one curarizing agent (see, for example, refs. 3 and 4), a number of the compounds illustrated in

Table 1. Paralysing activity and toxicity of decamethylene-*αω-bis* quaternary ammonium halides in the mouse

Compound No.	Q halide, where general formula is Q halide $(CH_2)_{10}$ Q halide	ED 50 in mgm. per kgm.	LD 50 in mgm. per kgm.	LD 50 / ED 50
1	quinolinium iodide	0·9	5·4	6·0
2	1.2.3.4.-tetrahydroquinolinium methiodide	0·9	2·5	2·8
3	6-methoxyquinolinium iodide	1·3	3·6	2·8
4	6-methoxy 1.2.3.4-tetrahydroquinolinium methiodide	1·0	1·6	1·6
5	8-methoxy quinolinium iodide	0·8	1·1	1·4
6	8-methoxy 1.2.3.4-tetrahydroquinolinium methiodide	0·6	1·0	1·7
7	*iso*quinolinium bromide	3·6	25·6	7·1
8	1.2.3.4-tetrahydro*iso*quinolinium methiodide	1·9	3·1	1·6
9	pyridinium bromide	1·9	6·5	3·4
10	piperidinium methiodide	2·0	2·8	1·4
11	3-bromopyridinium iodide	0·5	5·8	11·6
d-tubocurarine chloride		0·1	0·2	2·0

Table 1 were administered intravenously to rabbits, with results expressed in Table 2.

All compounds tested showed some degree of paralysing activity. It may be inferred that paralysis was curariform in type, but no proof of this is offered in the present communication.

The results of experiments with mice suggest that this species does not discriminate finely between one compound and another of the type under investigation. For comparison of these compounds it appears better to base our conclusions upon the results obtained with the rabbit.

It will be seen from Table 2 that compounds in which the quaternary nitrogens are situated in a reduced ring (Nos. 2, 4, 6 and 8) show greater paralysing activity in the rabbit than do the corresponding unsaturated compounds (Nos. 1, 3, 5 and 7). This result is in agreement with Craig's[5] observations.

Compound 1 has been synthesized as the bromide by Barlow and Ing[6], who reported it to be an active anticholinesterase. Our observation of the behaviour of rabbits to which this compound has been administered supports these authors' conclusion, since we observed marked salivation and pupillary constriction in response to doses lower than those required to abolish the righting reflex. However, the corresponding 1.2.3.4-tetrahydro compound (No. 2), which chemically more closely resembles tubocurarine, does not produce salivation or pupillary constriction in the rabbit at corresponding dosage levels, and it possesses greater paralysing activity than compound 1.

Table 2. Paralysing activity and toxicity of decamethylene-*αω-bis* quaternary ammonium halides in the rabbit

Compound No.	Approx. min. dose to abolish righting reflex in mgm. per kgm. (= MED)	Approx. min. lethal dose in mgm. per kgm. (= MLD)	MLD / MED
1	4·5	12	2·7
2	0·75	2·5	3·3
3	Slight muscular relaxation at 4		
4	0·2	0·3	1·5
5	0·2	0·5	2·5
6	0·1	0·15	1·5
7	Slight muscular relaxation at 4		
8	1·5	2·0	1·3
11	8		
d-tubocurarine chloride	0·1	0·2	2

In view of the presence of methoxyl groups in the molecules of tubocurarine and its dimethyl ether, the effects of attachment of one of these groups in the 6- and 8-position to compounds 1 and 2 are of great interest. It will be seen from Table 2 that introduction of a methoxyl group in the 8 position increases the paralysing activity of both compounds. Introduction of a methoxyl group in the 6-position increased the activity of compound 2, but not of compound 1. It will be seen also that the 6-methoxy compounds (Nos. 3 and 4) are somewhat less active than the 8-methoxy compounds (Nos. 5 and 6).

The question arises as to whether prostigmine antagonizes the paralysing activity of the compounds described. We have so far only examined this for compounds 2 and 4, against which prostigmine exerts a powerful antagonism in the rabbit. This observation suggests that these compounds may resemble curare in their mode of action.

Compound 11 was prepared because of the statement[7] that a halogen atom in the 3-position considerably lowers the toxicity of certain quaternary ammonium compounds. We did not find compound 11 to be less toxic to mice than compound 9, although it did possess greater paralysing activity in this animal. In the rabbit, however, a large dose was required to produce paralysis, whereas smaller doses evoked marked salivation (*cf.* compound 1).

It is intended to publish this work in further detail later and to explore this field more fully.

We wish to express our thanks to Mr. W. C. Austin for help in the chemical work, and to Mr. R. A. Hall and Miss J. E. Pryke for help in the pharmacological work. We also wish to thank the directors of Allen and Hanburys, Ltd., for permission to publish this communication.

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Effect of Calcium on the Development of Streptococcal Bacteriophages

Bacteriophages attacking lactic streptococci used as cheese starters usually develop readily on the susceptible organisms growing in milk. On the other hand, in broth media which readily support bacterial growth, it is often found that phage proliferation is not sufficient to bring about complete lysis and clearing of the culture[1].

During an investigation into the detection of airborne phage by the use of agar plates spread with the susceptible culture, the distribution of plaques was most uneven and the plaques themselves were very variable in size. The plates were poured with Hunter's yeast lactose phosphate agar[2] which had been clarified with filter-aid, and two drops of culture grown in skim milk were spread over the surface. Usually maximum plaque development, both as to

numbers and size, occurred in the areas on which the drops were originally placed. Elsewhere the plaques were either very small or absent.

It was found that drops of cell-free milk serum produced the same effect and that the addition of 0·5 ml. of serum to 15 ml. of agar before pouring allowed good development of plaques all over the plate. Where previously the plaques had been less than 0·5 mm. in diameter, addition of serum gave plaques up to 1·5 mm. Unclarified agar also gave larger plaques with added serum.

Similarly, in a yeast extract lactose phosphate broth, in which phage development was not sufficient to produce complete lysis, addition of milk serum enabled lysis to proceed to completion and the broth became clear. Within limits, increasing amounts of serum produced more rapid clearing, at the same time forming an increasing amount of precipitate in the medium. On the assumption that the precipitate was calcium phosphate, calcium chloride was added and found to produce the same effect. Similarly, on agar calcium chloride produced a stimulation similar to serum.

Calcium has been found essential for the development of staphylococcal phage by Smith[3] and for certain coliform phages by Delbrück[4] and Doermann[5]. The well-known inhibition of certain phages by citrate is probably due to removal of calcium ions[6]. We have been able to reverse the stimulatory effect of calcium by addition of citrate.

The optimum amount of calcium chloride varies with different media, apparently according to phosphate content, and with the media used ranged from 0·02 *M* to 0·007 *M*. Stimulation of phage development was produced with as little as 0·001 *M*.

Eight phages for different strains of *Streptococcus cremoris* all need calcium for maximum development. Adsorption takes place without added calcium in yeast dextrose broth. Doermann[5] found that adsorption of the coliform phage, *T5*, could occur in the absence of calcium, but lysis did not follow. Delbrück[4] observed that calcium was essential for adsorption of a *T4* mutant. As the broth used in the present work was not completely calcium-free, it is not clear whether calcium is essential for adsorption or for later stages in the lytic process. It has not been possible to stimulate phage development with magnesium ions in place of calcium ions.

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Role of the Intestinal Flora in the Development of Vitamin E Deficiency

In some experiments, white rats were given the following basal diet: glucose 70, purified casein 20, salt mixture 4, arachis oil + 1,600 I.U. vitamin A and 150 I.U. vitamin D3, succinylsulphathiazole or phthalylsulphathiazole respectively 1 and vitamin mixture 2 (consisting of choline chloride 1 gm., nicotinic acid 50 mgm., thiamine hydrochloride 10 mgm., riboflavin 10 mgm., calcium pantothenate 50 mgm., pyridoxin hydrochloride 10 mgm., *p*-aminobenzoic acid 10 mgm., vitamin K 5 mgm. and glucose to 20 gm.).

This synthetic, vitamin E-deficient diet was given to 40 rats aged four to five weeks, and after forty to fifty days a depigmentation, particularly of the orange-coloured upper incisors, occurred, as described by Moore[1]. Histological examination of the incisors showed that the enamel organ had undergone some characteristic changes, consisting partly of a premature atrophy of the stratum papillare, and partly of the formation of cyst-like cavities in the ameloblasts.

If, however, vitamin E was given simultaneously in doses of 3 mgm. tocopherol daily, neither depigmentation of the incisors nor histopathological changes in the enamel organ occurred.

In a third experiment an amount of 20 per cent faeces from rats on a normal stock diet was added to the synthetic basal diet without vitamin E. In this case also no depigmentation of the incisors or histopathological changes in the enamel organ occurred.

On this basis it appears justifiable to assume that a bacterial synthesis of vitamin E takes place in the digestive tract of the white rat under certain conditions.

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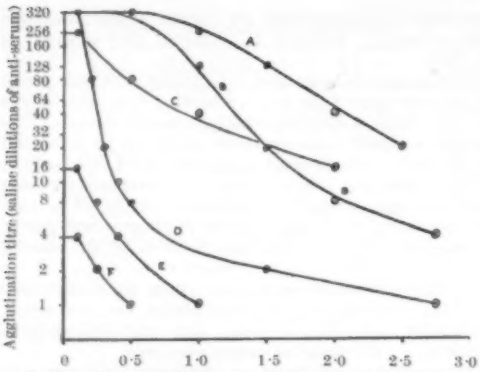
Inhibition of *Rh* Agglutination by Disodium Hydrogen Citrate

It was found that *Rh*-positive (that is, *D*-positive) red blood cells suspended in an anti-coagulant preservative solution (2 per cent disodium hydrogen citrate or 'acid citrate'; 2·5 per cent dextrose) were not agglutinated by anti-*D* grouping sera. Investigating this inhibition, 2 per cent *D*-positive cell suspensions were titrated with a strong anti-*D* serum. The titre of cells in isotonic (0·85 per cent) saline and in isotonic (5 per cent) dextrose was 320, but in isotonic mixtures of acid citrate and sodium chloride or dextrose the titre was reduced according to the acid citrate concentration.

In the accompanying figure, the results of titrations of cells containing the *Rh* factors C, D, E and c with corresponding anti-sera are shown, the titres given being the mean of at least three results. The acid citrate solutions were made isotonic with sodium chloride. The inhibition of agglutination occurs with acid citrate concentrations higher than 0·1 per cent, but the presence of serum decreases this effect. No inhibition took place of the agglutination of appropriate cells with anti-*A*, anti-*B*, naturally occurring anti-*M* or anti-*N* sera, or of the sensitization of *D*-positive cells with an incomplete anti-*D* serum.

No evidence was found in further experiments that a change of *p*H was inhibiting the *Rh* agglutination, or that the anti-*Rh* agglutinins became attached to the red cell antigens without the usual subsequent cell agglutination. But evidence was obtained suggesting that the acid citrate was absorbed by the red cells and prevented their reaction with the agglutinins.



A, D-positive cells in 100 per cent serum; *B*, D-positive cells in 50 per cent serum; *C*, c-positive cells; *D*, D-positive cells; *E*, C-positive cells; *F*, E-positive cells

However, when the 120-ml. anti-coagulant solution in the blood-collecting bottles are diluted to 540 ml. with blood, the diluted acid citrate in the presence of plasma does not affect the *Rh* agglutination of the red blood cells.

This work was carried out at the South-West Regional Blood Transfusion Centre, Southmead, Bristol.

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Distribution of the Sickle-Cell Trait in Uganda, and its Ethnological Significance

It has been known since 1910 that the red blood corpuscles of some Negroes assume a peculiar sickle shape when deprived of oxygen. The condition is hereditary, transmitted on Mendelian lines, and is estimated to affect some 7·5 per cent of North American Negroes[1]. In the majority of those affected no disability is present; but a small proportion is alleged to develop a chronic hæmolytic anæmia, and it is this aspect, rather than the inherited abnormality itself, that has claimed the attention of most medical writers on the subject. Although our interest was primarily medical, some of our findings appear to have a bearing on anthropology, and are therefore presented here.

Estimates of the incidence of the sickle-cell trait ('sicklæmia') have been made at various places in tropical Africa; but only in Northern Rhodesia have tribal incidences been recorded[2]. In Uganda we were struck by a remarkable difference in incidence between certain African tribes, and extended our observations over the whole Protectorate.

Uganda lies at the point of contact of several ethnological groups, in particular the Hamites, Nilotes and Bantu. Thus widely differing tribes could be studied within a comparatively small area. Another factor facilitating our work was the recent discovery of methods which ensure rapid and complete sickling of all susceptible cells[3].

Nearly 5,000 persons—about 1 in 1,000 of the population of the Protectorate—have been examined. Both sexes and all ages were included, but will not be treated separately here. The results are set out in brief in the accompanying table; in each main language-group are shown tribal sub-groups in which the incidence of sicklæmia does not differ significantly between the various tribes composing the sub-group. Between any two sub-groups of a given language-group, however, the differences in incidence are statistically significant. The only exception is in the case of the Bakenyi tribe, which is shown separately because it is really a mixture of the original tribe and a variety of Bantu refugees, all living until recently on papyrus swamps of Lake Kyoga.

Distribution of sicklæmia in Uganda

Language group	Tribe	Number examined	% of sicklæmia
Hamitic	Bahima*	166	2·4
	Sebei	124	0·8
	Suk	128	3·9
	Karamojong	156	3·2
	Teso	416	17·8
Nilotic	Lango	278	27
	Acholi	141	27
	Jaluo	130	28
	Lugbara	120	21
	Kakwa	101	25
	Alur	114	25
	Jonam	109	26
	Madi	109	3
Bantu	Bairu	139	2
	Banyaruanda (Bahutu)	496	8
	Banyoro	91	12
	Batoro	120	12·5
	Baganda	740	19
	Bakonjo	102	18
	Barundi	108	19
	Bakenyi	88	26
	Basoga	241	29
	Bagishu	207	30
	Baamba	140	45

* Although the Bahima now speak the Bantu language of their subjects, they have—for obvious reasons—been included in the Hamitic group.

In the following discussion we wish to do no more than indicate how our results bear on physical anthropology. The incidence of the sickle-cell trait is uniformly low in the pastoral, Hamitic-tongued tribes, with the single exception of the Teso. The latter, however, have not the Caucasian features of Hamite stock; they are a largely agricultural group, settled amid and intermingling with Nilotes and Bantu. Their possession of the sickle-cell trait in considerable intensity is an additional physical character distinguishing them from the Hamitic group with which they have been classed on a linguistic basis.

The Nilotic tribes, according to the Uganda handbook[4] composed of the Gang, Bari and Madi-Moru speakers, are remarkably homogeneous with regard to sicklæmia, excepting only the Madi (on the Sudan border). The Lango, who live between the Acholi and the Teso, appear from our findings to fall uncompromisingly within the Nilotic group. This is of interest because the presence of some Teso words in their language has been used as evidence that they are in reality a branch of the Teso who have adopted an easier Nilotic language[5].

Unlike the two previous groups, a wide variation is seen among the Bantu tribes. The incidence of

sicklæmia appears to be inversely proportional to the contact the various tribes have had with their most recent Hamitic invaders. Thus the trait is least common among the Bairu, who have lived for generations as helots to the ruling class of Hamitic conquerors, the Bahima, on the best pastoral land in Uganda. Next come the Banyaruanda, Banyoro and Batoro, whose traditions and customs testify to prolonged contact with the Bahima, and whose aristocracy possesses Hamitic features. The contact of the Baganda, Bakonjo and Barundi with Hamitic peoples in recent times has probably been less direct and made by way of their neighbours, the Banyoro, Batoro and Banyaruanda.

The Basoga and Bagishu, two closely related tribes, live remote from the track of the Hamitic peoples. The South Basoga, to whom the accompanying table refers, live in the swampy country between Lakes Victoria and Kyoga. The Bagishu live on the western slopes of Mount Elgon. There is no history of direct contact with Hamitic tribes, though tradition records hostile relations with the Jaluo of the neighbouring plains, themselves a tribe of high sickle-cell incidence.

The Baamba are a secluded tribe living west of the Ruwenzori Range. They are composed of the Babullibulli and Bamwezi, who differ in language and in some physical characteristics, but show the same incidence of sicklæmia. They claim to be autochthonous, and of all the tribes we have investigated these pigmoids are furthest removed from the Bahima in physical appearance.

We consider that, so far as Central Africa is concerned, a study of the distribution of sicklæmia could usefully contribute to physical anthropology.

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Stimulation of the Uropygial Gland in the Female Indian Spotted Munia, *Uroloncha punctulata* (L.), Due to Œstrogen Treatment

Hooker and Pfeiffer[1] observed an atrophy of the uropygial gland in rats after œstrogen treatment. This atrophy was prevented by androgen therapy. Bullough[2] reported stimulation of this gland in the mouse due to the administration of œstrogen, and further noted that prolonged œstrogenic treatment caused a depression of this gland. However, Kar[3] observed that the œstrogen failed to elicit any response in the uropygial gland of White Leghorn cockerels. This hormonal ineffectiveness was explained by the assumption that the female sex hormone failed to influence this sebaceous type of gland in the cockerels with functioning testes. The present report has been concerned with an attempt to test the validity of this assumption with female birds as the experimental material.

The juvenile female spotted munia involved in this study were injected intramuscularly with alpha-œstradiol benzoate (125 R.U. daily) for a period of 25 days. Uninjected birds served as the controls. Twenty-four hours subsequent to the final treatment, the birds were autopsied along with the control specimens. The uropygial glands were dissected out and weighed to the nearest milligram. The results obtained are presented in the accompanying table.

	Number of birds	Weight of uropygial gland		Body-weight at autopsy (gm.)
		Absolute (mgm.)	Relative* (per cent)	
Uninjected controls	10	55·5±1·5†	0·0042	13·8±0·2
Œstrogen-treated	10	122·2±1·8	0·0087	14·0±0·5

* Uropygial gland weight as percentage of the body-weight.
† Standard error of the mean.

It will be appreciated from the table that the uropygial gland was stimulated as a result of œstrogenic treatment. The present report, therefore, strengthens my view that the œstrogen shows marked sex specificity in influencing the uropygial gland[3]. However, a question may be raised as to whether the action of alpha-œstradiol benzoate is independent of the presence of the ovary. Since the œstrogen was without any effect on the latter[4], it appears probable that its action on the uropygial gland was a direct one.

Grateful acknowledgment is made to Dr. E. Maldonado, of the Schering Corporation, Bloomfield, N.J., for the contribution of alpha-œstradiol benzoate ('Progynon B') used in this study.

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Multipolar Meiosis in *Elephantulus*

One of the males used for a cytogenetical investigation of *Elephantulus myurus jamesoni*, the South African jumping shrew, showed a high incidence of multipolar meiotic divisions. This was not referred to in the original reports of the cytogenetics of *Elephantulus*[1,2] and is described below. In a count of a hundred first meiotic metaphases and anaphases, 75 per cent of the divisions were multipolar and, of these, the vast majority were divisions with tripolar spindles. Fig. 1 is a photomicrograph of a typical tripolar first meiotic metaphase.

Multipolarity was confined to the meiotic divisions; the mitoses were normally bipolar. The consequences of these multipolar divisions are maldistribution of the chromosomes at anaphase (Fig. 2, *a*, *b*, *c*, *d*) with resulting chromosomal abnormalities of the daughter nuclei. Fig. 2 also shows that the tripolar spindle splits into three adjacent spindles at anaphase. Occasionally, diagonal spindles are found as well.

At the poles of these multipolar spindles, a clearly defined centrosome is always observed. This indicates

Fig. 1. Photomicrograph of tripolar meiotic metaphase. ×2,600

that the tripolar spindles are probably the result of aberrant division of the centrosomes.

Experimentally, multipolarity has been produced in a variety of ways. Darlington[3] quotes references to the induction of multipolarity by cold and chloral hydrate, and to its occurrence in abnormal hybrids and aberrant fertilization (dispermy). Multipolar mitosis has also been induced by X-rays[4], and by high temperature in tissue culture[5]. However, even with this experimental evidence, it is still difficult to account for the high incidence of multipolar meiosis in *Elephantulus*. It may be that the aberration was confined to a single wave of meiosis, since the spermatids and spermatozoa in advance of the multipolar divisions in the tubules were normal and since the pachytene nuclei preceding these divisions in the tubules contained only two centrosomes. On the other hand, it is possible that multipolarity is of more general occurrence, since every tubule in the testis that showed meiotic metaphases contained the high percentage of multipolar divisions. If this is the case, then the centrosomes divide abnormally after the pachytene stage and the conditions inducing multipolarity affect meiosis differentially, leaving the mitotic divisions unaffected.

It is possible that the more general effect may be due to seasonal factors. This is suggested by the fact that the animal which showed the multipolar meiosis was obtained in September, during early spring and in the breeding season of *Elephantulus*. Other animals killed in April and May of the same year contained normal, bipolar meiotic divisions. The mediation of such seasonal factors, for example, temperature, may be directly on the testis or through the general metabolic processes of the individual.

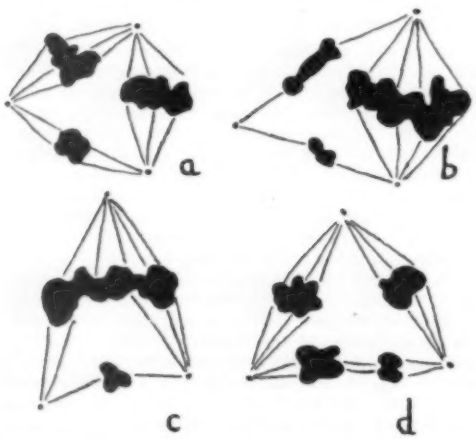

Fig. 2. Camera lucida drawings of tripolar meiotic anaphases. × 2,200

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Effect of Spacing on the Bolting of Onions

THE effect of spacing on the incidence of 'double' and 'bottle-necked' onions has been reported in the literature; but the effect on bolting is not mentioned. Wilson[1] found in his Utah experiments that thinning stimulates the formation of double onions and scallions. He maintains that doubling is a type of vegetative growth and is stimulated by the increased supply of available nitrogen resulting from thin stands. Bremer[2] reports that under the climatic conditions of mid-Europe wide spacing increases the incidence of bottle-necked onions. The relation does not apparently occur in Egypt, where wide spacing is customary, presumably owing to a difference in varietal responses. In Bremer's opinion the wider spacing associated with outside rows discourages ripening, since the effects of accelerated carbon assimilation are outweighed by the increased uptake of nitrogen.

In connexion with a fertilizer experiment of factorial design carried out in Lincolnshire, the results of which will be reported elsewhere, it was noticed that bolting appeared to be more prevalent around the edges of the experimental plots than in the inside rows. Each plot consisted of ten rows 10 in. apart and covered an area 7 ft. 6 in. square, and the plots were separated from each other by gaps 20 in. wide. Counts of bolters on fifty-four plots were taken in both outside rows (1 and 10), in one of the rows just inside the edge (9) and an inside row (6). The percentages of bolters in each row were transformed by square root transformation. The mean variates and percentages calculated from these variates are given below:

Row	1	6	9	10	
Transformed variates	2·54	2·16	2·61	2·63	(159 d.f.)
Percentages	6·0	4·2	6·8	6·4	Signif. diff. 0·144

The results show that the percentage of bolters in row 6 is significantly lower than in the other recorded rows. The effects of fertilizer treatments were neglected in this analysis; but the wide range of treatments in a factorial arrangement makes any interference from this source very unlikely. Moreover, possible differences in the response of outside rows to fertilizers would not apply in the case of row 9, which was well within the area of treatment. It can therefore be assumed that the differences in the incidence of bolting were entirely due to the position in the plot. The conditions on the periphery of the plots would obviously be characterized by reduced

competition for soil moisture and nutrients as well as improved illumination. The soil was well supplied with the major elements, with the exception of potassium, which was rather low. Comparisons between the experimental plots showed no definite correlations between phosphate and potash applications and bolting; but with nitrogen dressings the reduction in the percentage of bolters was just significant. It is likely that under conditions of ample nitrogen supply the reduced competition for light constitutes the determining factor. Apparently the onion plant responds to an increased rate of photosynthesis with a greater readiness for flower-stalk formation.

These incidental observations would warrant further work, specifically designed to investigate the effect of spacing on bolting under a variety of nutritional conditions.

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Geological Diffusions in Solid Phases

IN contradiction to the magma theory of the formation of granites, certain geologists have in recent years put forward the hypothesis that granite as well as gneiss is derived from transformed sediments. The upholders of the magma theory view the formation of granite as a differentiation of silicate *melts*, and the changes in the chemical composition of the rocks as a consequence of transport in volatile phases[1]. The 'transformists', on the other hand, hold the opinion that transformation of sediments can occur in the solid state, the transport of matter taking place by diffusion in crystalline phases[2]. While Backlund still considers that a mobility of the "granite frontier" in the sediments within the geosynclines may occur through concurrence of volatile substances, that is, that differential melting takes place[3], Bugge, on the other hand, advocates the theory that the introduction and removal of components at the formation of rocks may take place solely through diffusion in solid phases[4].

As soon as Bugge put forward the idea of a long-distance diffusion in solid phases, the chemist was faced with the question: What thicknesses of layers can be formed through diffusion in solid phases under the most favourable conditions at the reaction times in question (of a magnitude of 10^8 years)? It is known from earlier investigations that the valency of the diffusing substances is one of the most important factors influencing the diffusion velocity within solid substances. We have shown, for example, that at the formation of silicate in the system PbO–SiO_2 [5], or at the formation of spinels in the system ZnO–Al_2O_3 [6], the transport of matter is accomplished solely by migration of the oxides of the divalent zinc and lead, while silica and alumina do not move. Preliminary experiments showed that the oxides of the monovalent alkali metals have a still higher diffusion velocity at the same temperatures.

In order to get an idea of the maximum thickness of those layers which might be formed during geological times through diffusion processes in sediments, we therefore investigated the diffusion velocity of Na_2O in a number of aluminium–silicon compounds, such as metakaolin, sillimanite, albite and nephelite. In all these systems the diffusion velocity is of the same magnitude throughout the temperature interval investigated. The quantity of Na_2O (Δm) diffused during the time of the experiment (t) can be expressed by the equation

$$\Delta m^2 = k'' \cdot t.$$

At the reaction between metakaolin and sodium carbonate in the solid state, carnegieite is formed. The dependence of the velocity constant on the temperature can, for this process, within the temperature interval investigated, be described by the formula

$$k'' \sim 8 \times 10^{14} \times \exp(-95{,}000/RT) \text{ . gm.}^2\text{cm.}^{-4}\text{hr.}^{-1}.$$

The thickness of the layer of the reaction product which has been formed by the diffusion process can be calculated from the experimentally determined constant k'' by using a constant k' with the dimension $\text{cm.}^2\text{hr.}^{-1}$. The quantity of Na_2O diffused per sq. cm. is

$$\Delta m/\text{cm.}^2 = \rho \times x \times \frac{M_{Na_2O}}{M_{\text{carneg}}};$$

where ρ is the specific gravity of the reaction product, x the thickness of the layer, M_{Na_2O} the molecular weight of sodium oxide, and M_{carneg} the molecular weight of the reaction product. Therefore

$$(\Delta m/\text{cm.}^2)^2 = k'' \times t = \rho^2 \times x^2 \times \left[\frac{M_{Na_2O}}{M_{\text{carneg}}}\right]^2;$$

and as $x^2 = k' \times t$, we obtain

$$k' = k'' \left[\frac{M_{\text{carneg.}}}{M_{Na_2O}}\right]^2 \times \rho^{-2},$$

or, with $\rho \sim 2{\cdot}5$, $k' = k'' \times 3{\cdot}35$.

The thickness of the layers of sodium-aluminium silicate formed during different times of reaction and at different temperatures can consequently be calculated from the equations

$$k' = 2{\cdot}7 \times 10^{15} \times \exp(-95{,}000/RT)$$

and

$$k' = x^2 \times \frac{1}{t} \text{ cm.}^2 \text{ hr.}^{-1}.$$

The thicknesses of carnegieite layers calculated in this way for the geological time of formation of 10^8 years at a temperature of 700° C., and, after extrapolation, at the temperatures 600° C. and 500° C., should therefore constitute the maximum layers that might be formed exclusively by diffusion in the solid phase, and in the absence of any transport of matter by convection currents in volatile phases.

Temperature in ° C.	Layer in cm. after 10^8 years
700	1,000
600	60
500	1·8

According to this result, the diffusion velocity is so low that the reaction layer only attains a thickness of a few dozens of feet, and this result is only reached in the most favourable conditions, namely, diffusion of Na_2O, temperature close to the melting point, longest conceivable time of reaction. There should be a marked decrease in the thickness of the layer at lower temperatures and in other systems.

There can be only one conclusion: diffusion solely in solid phases cannot play any important part in the transport of matter over *long* distances. The assumption of transportation of matter by convection in volatile phases appears unavoidable at the transformation of sediments, combined with transmission and removal of material from and to considerable distances. This result does not, of course, exclude the possibility of a transformation in the solid state of sedimentary deposits of considerable magnitude, on the supposition, either that the reaction partners are present in a sufficiently intimate mixture already before the orogenic processes begin, or that the transport of the components to sufficiently divided sediment layers (cracking) in the case of greater distances occurs through convection in liquid phases. It is known that the presence of gaseous phases does not exclude such diffusion processes in the solid state as determine the velocity of the reaction. Whether such processes play any part, or whether the metamorphoses take place via quantitatively small melted phases, must be determined by investigating each separate case.

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Electrophoresis of Proteins in Agar Jelly

THE ease with which ionophoretic separations of amino-acids and lower peptides can be carried out in a rectangular slab of silica jelly[1] suggested that a similar technique might be useful for separating the proteins. The first problem was to find a convenient jelly which would allow the free migration of large molecules. The unsuitability of silica jelly for this purpose was shown when an attempt was made to cause hæmoglobin to migrate into its surface. Unfortunately, the protein became fixed less than 1 mm. from the surface of entry. A 1 per cent agar jelly, on the other hand, was found to allow the protein to migrate.

Further experiments with coloured proteins showed that agar can permit the migration of molecules as large as that of hæmocyanin (mol. wt. 8,500,000). Using this jelly, a complete separation of ferritin and hæmoglobin was achieved after 19 hours at 3·3 volts per cm. (Fig. 1). Accurate measurements would be necessary to determine whether the mobilities of the proteins are noticeably affected by the presence of the agar jelly. These have not yet been attempted; but the ability of molecules as large as that of hæmocyanin to migrate suggests that the effect is likely to be small, at least for the proteins of lower molecular weight. That proteins can be recovered unchanged after such separations is indicated by the recovery of ferritin in crystalline form after its diffusion out of the agar at the end of the separation.

The above findings encouraged us to investigate the separation of mixtures of colourless proteins. The technique used was as follows. At the start of each

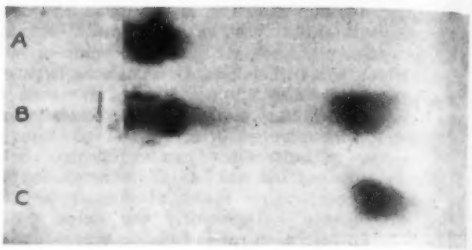

Fig. 1. Separation of ferritin and hæmoglobin. The protein solutions, stabilized with potato starch, were originally placed in three holes towards the left side of the jelly. Both proteins have migrated towards the cathode. *A*, ferritin; *B*, ferritin-hæmoglobin; *C*, hæmoglobin

experiment, the mixture to be investigated was set in 1 per cent agar as a band transverse to the direction of migration. After passage of current for a suitable time, the jelly was investigated in two successive ways. First, after removal of the glass cover from the upper surface of the jelly a print was taken as described by Consden *et al.*[1], except that Pauli reagent was used for spraying instead of ninhydrin. In the light of this information, more detailed investigations were made by measuring the ultra-violet absorption of appropriate parts of the jelly. This was done by cutting out successive sections of the jelly, each 1 cm. wide, and carefully sliding each into the cuvette of the Beckmann spectrophotometer. The absorption at 280 mμ was found in general to correspond with the depth of colour given by the Pauli reagent.

This technique was first applied to a specimen of 'Difco' 1 : 10,000 pepsin which, at *p*H 5·3 in sodium acetate buffer, showed two main bands, one moving towards each electrode. The print with Pauli reagent showed a much wider cathode band than that indicated by the ultra-violet absorption. Results of this kind suggest the presence of proteins rich in histidine or some other substance reacting with the Pauli reagent but not absorbing in the ultra-violet.

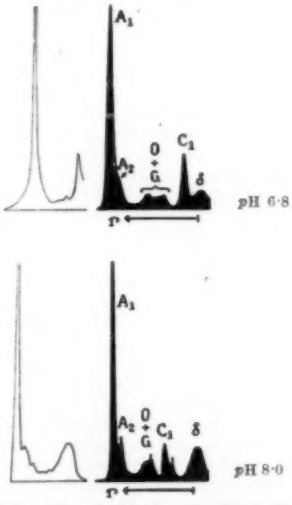

Fig. 2. Comparison of electrophoretic diagrams of egg white proteins in agar (left) (abscissæ, electrophoretic movement, ordinates, arbitrary units of ultra-violet absorption) and by the Tiselius technique (right)

The second mixture subjected to separation consisted of the proteins of egg white. Results obtained at two different *p*H's are shown on the left of Fig. 2. The top half of the figure represents a separation at *p*H 6·8, the bottom at *p*H 8·0. The solid curves on the right, which are shown for comparison, were obtained from egg white at the same *p*H values by Longsworth, Cannan and MacInnes[2] in the usual Tiselius apparatus. Direct comparisons are not valid as the spectrophotometer curves are, of course, determined by the content of tyrosine and tryptophane in each protein. Despite this, a general similarity is apparent, especially at *p*H 6·8. The egg white was placed in the jelly just to the left of the position finally occupied by the strongest absorbing component. All the bands migrated towards the cathode. No correction has been made for electro-endosmosis through the jelly.

Electrophoretic separations conducted in jelly may presumably be expected to have certain advantages and certain disadvantages compared with those done by the well-known technique of Tiselius. Probably the greatest advantage is that, as in jelly stability of the layers under separation is not due to differences of their specific gravity, discrete bands of protein can be completely separated from one another. This means both that observations need not be confined to 'fronts' and that the method is essentially more suitable for the isolation of individual substances. Another effect of jelly stabilization is that mixtures of small and large molecules can be separated simultaneously. Also the apparatus required is very simple to construct.

The range of *p*H in which agar can be employed is limited to that in which it does not cause precipitation of any of the proteins to be separated. For the proteins of egg white, precipitation is noticeable below *p*H 5. Probably the chief disadvantage involved in the use of agar is the difficulty of its complete removal from the substances under investigation at the end of the experiment. However, an electrodialytic technique has been evolved during the present work which shows some promise of solving this problem. It is hoped to publish a detailed account of these experiments later in the *Collection of Czechoslovak Chemical Communications*.

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The Amylolytic Enzymes of Soya Bean

The most reliable method for distinguishing quantitatively between the branched and unbranched components of starch has depended upon the degree of hydrolysis to maltose effected by an amylase of the beta-type. The branch points in a ramified structure (amylopectin) represent obstructions which the enzyme cannot surmount in the course of its normal function of progressively splitting off maltose units, one at a time, from non-reducing chain-ends. In consequence, the action of beta-amylase on amylopectin ceases at about 50 per cent conversion to maltose. Obviously a chain molecule with no branches would be completely converted into maltose, and indeed in the earlier literature amylose is more or less defined as that component of starch which, on beta-amylolysis, yields 100 per cent maltose. Actually, in our experience, an amylose of this degree of purity (total absence of branching) has not been obtained.

It is clear that the enzymic purity of the beta-amylase preparations used in such diagnostic experiments is of the first importance. The favoured source of beta-amylase has been the ungerminated grain of wheat or barley; but as such preparations were frequently contaminated with alpha-amylase, we found it more convenient to use soya bean as the source[1].

In 1946, A. K. Balls and his associates reported the isolation in crystalline form of the beta-amylase of sweet potato[2]. This notable achievement provided for the first time a preparation which could be confidently regarded as pure beta-amylase. Dr. Balls, to whom we wish to express our grateful thanks, presented us (through Sir Norman Haworth) with a generous sample of the crystalline enzyme which we proposed to use as a standard of reference in our work on the purification of soya bean amylase.

It was at once evident that the crystalline enzyme behaved differently from any other beta-amylase preparation with which we were familiar. By its agency amylose was rapidly converted to maltose. The characteristics of this conversion were those ascribed to a beta-amylase, but the conversion of the amylose did not approach 100 per cent. Reaction ceased abruptly at about 70 per cent conversion, even in the presence of a large excess of the enzyme, and the digest never became achroic. Furthermore, the same early arrest point was observed at three different *p*H values, as recorded in the accompanying table, in which soya amylase is compared with crystalline beta-amylase with respect to their hydrolytic action on potato starch and its components. The 'stock soya bean' preparation was obtained by the extraction procedure of Bourne, Macey and Peat[1], in which no special measures are taken to eliminate enzymic impurities. Nevertheless, the stock soya bean preparation was consistently free from more than traces of alpha-amylase or maltase. To reduce any alpha-amylolysis to a minimum, digestion was carried out at *p*H 4·8 (Bernfeld[4] gives the optimum *p*H for alpha-amylase as 6·9).

Beta-amylolysis of potato starch and its components at 35° C.

Enzyme preparation	*p*H of digest	Amylose (B.V. 1·24)		Amylopectin (B.V. 0·196)		Starch (B.V. 0·468)	
		% Conv.	A.V. (6800)	% Conv.	A.V. (6800)	% Conv.	A.V. (6800)
		At arrest point					
Crystalline (Balls)	4·8	72·2	0·300	55·0	0·107	58·1	0·160
Stock soya bean	4·8	87·0	0·112	54·5	0·111	64·5	0·120
Crystalline (Balls)	3·6	71·2	0·270	54·3	0·106	58·4	0·177
Stock soya bean	3·6	71·5	0·311	55·0	0·110	61·9	0·162
Crystalline (Balls)	5·6	70·7	0·305	55·1	0·112	59·8	0·155
Stock soya bean	5·6	90·9	0·050*	>63	0·060*	>71	0·060*

Notes: (1) Blue value (B.V.) and absorption value (A.V.) are quantitative expressions of iodine-staining power and are defined by Bourne, Haworth, Macey and Peat (ref. 3). (2) % Conv. = Percentage of polysaccharide converted to maltose. * Achroic.

The results given in the accompanying table may be summarized as follows: (1) At *p*H 4·8, the stock soya bean enzyme effects conversion of an amylose (of moderately high blue value) to the extent of 87 per cent, whereas the action of the crystalline enzyme ceases at 72 per cent conversion. When, however, digestion is carried out in a more acid medium (*p*H 3·6), the two enzymes behave in identical fashion. The arrest point of the soya bean enzyme is now the same as that of the crystalline beta-amylase, namely, at 71–72 per cent conversion. The increased acidity would appear to inhibit a factor, *Z*, in the stock soya bean extract, the presence of which enables the hydrolysis of the amylose to proceed much further at the higher *p*H (4·8). This factor is not present in the crystalline amylase, inasmuch as the degree of conversion effected by this preparation is the same (72 per cent) at *p*H 3·6 as it is at *p*H 4·8.

(2) The factor *Z* does not influence the limit of conversion of amylopectin. The limiting conversion of a pure amylopectin by each enzyme preparation is the same (54–55 per cent) and, moreover, is unaffected by *p*H change from 4·8 to 3·6.

It might be argued on the basis of the results with amylose alone that the factor *Z* was an alpha-amylase which could function at *p*H 4·8 but which was inhibited at *p*H 3·6. It would then be necessary to assume that potato amylose was much more highly branched than had hitherto been supposed. It appears to us, however, that the equating of alpha-amylase with the factor *Z* in the soya preparation cannot be reconciled with the facts that the limit of conversion of amylopectin at *p*H 4·8 by this preparation is no higher than that effected by the crystalline enzyme, and that the hydrolysis of amylose or amylopectin never attains the achroic stage. A trace of an alpha-amylase, if it functioned at *p*H 4·8, would manifest itself by rapidly carrying the hydrolysis of both starch components beyond the iodine-staining stage.

A small proportion of a true alpha-amylase is undoubtedly present in the crude soya bean extract, but it is inhibited at *p*H 4·8. Its presence is demonstrated when digestion is carried out at *p*H 5·6 (see table). At this more alkaline *p*H, the crystalline enzyme gives, with both amylose and amylopectin, the same conversion end-points as at the other *p*H values; but the soya preparation carries the conversion of each beyond the limits shown at *p*H 4·8, and, moreover, the solutions become achroic. Indeed, no true arrest point is observable in the case of amylopectin, the conversion continuing long after the achroic stage has been reached. It will be noted (see table) that whole starch behaves in this respect as a mixture of amylose and amylopectin.

We are forced to conclude that preparations of soya bean enzyme which in the past have been used as sources of beta-amylase are, in fact, mixtures of a beta-amylase of the Balls' type and a factor *Z* which is probably an enzyme since it is heat-labile. When the stock soya bean preparation was held in solution at 60° C. for 30 min., the factor *Z* was preferentially destroyed, leaving an enzymic solution which, at *p*H 4·8, was indistinguishable in its action from the crystalline beta-amylase.

The nature and function of the factor *Z* are at present unknown. The possibility is being explored of it being a phosphatase. If this is substantiated, then it implies that potato amylose contains ester phosphate groups which obstruct the normal action of the true beta-amylase. This view is difficult to accept, particularly as we have found the same effects with many starches other than potato, some of which have no detectable phosphate content.

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[2] Balls, A. K., Thompson, R. R., and Walden, M. K., *J. Biol. Chem.*, **163**, 571 (1946).
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Cleavage of the Carbon Chain of Some Amino-Alkyl Tertiary Carbinols

SUBSTITUTED 3-amino-1 : 1-diphenylpropan-1-ols (I) behave in orthodox fashion when boiled in acid solution, to give the expected substituted allylamines (II) in almost quantitative yield[1]. Partial de-amination to the corresponding allene occurs in some cases, for example, 3-piperidino-1 : 1 : 3-triphenylpropan-1-ol (III, m.p. 107°) gave dimeric 1 : 1 : 3-triphenylallene (IV) as well as the unsaturated amine (V, m.p. 103–104°) when boiled in a mixture of concentrated hydrochloric and acetic acids.

$CPh_2(OH).CH_2.CH_2.NR^1R^2$ (I) $\quad CPh_2 : CH.CH_2.NR^1R^2$ (II)

$CPh_2(OH).CH_2.CHPh.NC_5H_{10}$ (III) $\quad [CPh_2 : C : CHPh]_2$ (IV)

$CPh_2 : CH.CHPh.NC_5H_{10}$ (V) $\quad CPh_2 : CH.CHPh.OCOMe$ (VI)

$CPh_2 : CH_2$ (VII)

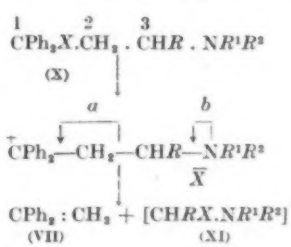
The carbinols suffer decomposition when boiled for a short time with acetic anhydride, to give, not the expected allene, but 1 : 1-diphenylethylene (VII) in high yield. This cleavage of the three-carbon chain does not proceed through the intermediate formation of the unsaturated amines, since these on boiling with acetic anhydride are de-aminated to substituted allyl acetates in which the original carbon chain is intact; for example, (V) gave a high yield of (VI) (m.p. 71–72°) when boiled with acetic anhydride.

Further, the hydrochloride of the chloro-derivative (VIII) (m.p. 157°, prepared from the carbinol by treatment with hydrogen chloride or thionyl chloride in benzene), when dissolved in excess pyridine and warmed on the steam bath, is similarly degraded to 1 : 1-diphenylprop-1-ene (IX). Finally, this degradation may be brought about, in the absence of reagents, by heating certain carbinols the phenyl groups of which carry electron-releasing substituents; for example, 1 : 1-di(4′-methoxyphenyl)-ethylene was obtained in high yield by heating 3-diethylamino-1 : 1-di(4′-methoxyphenyl-propan-1-ol (m.p. 78–79°) at 200° for 15 minutes.

$CPh_2Cl.CHMe.CH_2.NC_5H_{10}$ (VIII) $\quad CPh_2 : CHMe$ (IX)

The fate of the other fragment of the molecule has not yet been determined except in the reaction of (III) with acetic anhydride when, in addition to 1 : 1-diphenylethylene, cinnamic acid was isolated in 33 per cent yield.

It is evident that this degradation involves the unusual step of a direct cleavage of a saturated carbon chain. It is envisaged as arising from the separation of the anion X^- from (X) (X = OH, Cl or OCOMe) with consequent electronic re-arrangement in the cation, the electron displacement *a*, assisted by *b*, entailing breaking of the bond between carbon atoms 2 and 3. At the same time the anion becomes attached to the electrophilic carbon atom 3, presumably to give (XI) or decomposition products thereof. The hypothetical intermediate (XI) (R = Ph, X = OCOMe) from (III) will react further with acetic anhydride to give cinnamic acid by a mechanism similar to that involved in the Perkin reaction.



This reaction, which might be regarded as an anionotropic degradation, is reminiscent of the anionotropic re-arrangement of allyl esters[2]; in the latter reaction, however, the electron shift consequent upon the separation of the anion can be accommodated, without cleavage of the carbon-carbon bond, since the cation is already unsaturated.

Further work is in progress to determine the generality of this reaction.

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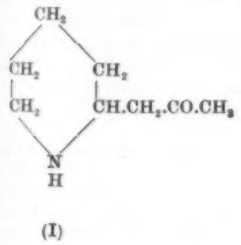
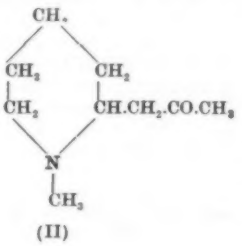
A Synthesis of *iso*-Pelletierine and Methyl *iso*-Pelletierine

According to Robinson's[1] theory of the biogenesis of alkaloids, the piperidine (that is, coniine) group of alkaloids is derived from *iso*-pelletierine (I) and methyl *iso*-pelletierine (II), which are formed by the condensation of δ-amino- and δ-methylamino-valeraldehydes respectively with acetoacetic acid or acetone dicarboxylic acid.

We have now prepared both δ-amino- and δ-methylamino-valeraldehyde diethylacetals and have found that after mild acid hydrolysis to the corresponding free aldehydes the alkaloids (I) and (II) can be synthesized by condensation with acetoacetic acid in dilute aqueous solution at room temperature. The yield of (II) at *p*H 7 was more than 70 per cent, but at this *p*H (I) was formed in traces only. However, at *p*H 11 a yield of about 50 per cent of (I) was obtained. In each case the identity of the alkaloid was established by its boiling point and by the melting points and analyses of several of its derivatives.



(I)



(II)

While this work was in progress there came to our notice a report by E. Herzog[2] of a lecture delivered by C. Schöpf. Although the report contains several obvious misstatements or misprints, it does state that Schöpf has synthesized (I) from Δ-1-piperideine[3] and acetoacetic acid at *p*H 11, but no mention is made of (II).

Full details of our work will be published elsewhere in due course.

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Identification of the End-Amino Groups of Wool by Means of their 2 : 4-Dinitrophenyl Derivatives

The amino-acids with free α-amino groups in wool have been identified using Dr. F. Sanger's technique[1]. Considerable use was made of buffered, as well as unbuffered, silica gel columns, using Sanger's original solvents. The gel was buffered at *p*H 6·0 with 0·5 ml. buffer solution (9·36 gm. $NaH_2PO_4.2H_2O$ + 14·32 gm. $Na_2HPO_4.12H_2O$ per 100 ml. solution) per gm. silica. This was used in conjunction with (*a*) ether, (*b*) 1 per cent butanol–chloroform, (*c*) 30 per cent butanol–chloroform, (*d*) 5 per cent propanol–cyclohexane, (*e*) 33 per cent ether–ligroin as solvents. The ether was freed from peroxides by shaking with an acid solution of ferrous ammonium sulphate, followed by several changes of distilled water, and stored in a dark bottle. In agreement with other workers[2,3], leucine could not be separated from valine on unbuffered columns, but this was easily achieved by using 0·5 ml. solution (7·16 gm. $Na_2HPO_4.12H_2O$ + 7·60 gm. $Na_2PO_4.12H_2O$ per 100 ml. solution) per gm. silica with ether as solvent. The acids were identified as (*a*) valine, (*b*) alanine, (*c*) glycine, (*d*) threonine, (*e*) serine, (*f*) glutamic acid, (*g*) aspartic acid.

For quantitative determination of these 2 : 4-dinitrophenyl amino-acids, which is now being carried out, it is found most convenient to run the ether-soluble fraction on a 2-gm. silica gel column buffered at *p*H 6·0 with ether as solvent. This achieves individual separation of the glycine, threonine, serine, glutamic and aspartic derivatives in one operation, the valine and alanine moving as a fast band together with the decomposition products containing 2 : 4-dinitroaniline and 2 : 4-dinitrophenol. This mixture is run with chloroform on a column buffered at *p*H 7·2 with 0·5 ml. buffer solution (14·32 gm.

$Na_2HPO_4.12H_2O$ + 1·56 gm. $NaH_2PO_4.2H_2O$ per 100 ml. solution) per gm. silica. The decomposition products move fast, followed by the valine, R_F=0·2. The alanine remains at the top of the column and is removed by ether. The advantages of ether as a solvent is that it can be removed *in vacuo* at room temperature, thus minimizing any possible decomposition of the 2 : 4-dinitrophenyl amino-acids; and also its high solvent power for the latter, which results in strongly coloured, but sharp, bands with little tendency to tail.

Thanks are due to Mr. J. Tibbs for assistance with the diphosphate/triphosphate columns.

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[1] Sanger, F., *Biochem. J.*, **39**, 507 (1945).
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Inequalities between Average Molecular Weights of Polymers, and their Relations to the Distribution Function

(1) THE ratios between the weight and number average, M_w/M_n, or the z- and weight average, M_z/M_w, written explicitly as $\frac{\Sigma M_i^2 n_i \,.\, \Sigma n_i}{(\Sigma M_i n_i)^2}$ and $\frac{\Sigma M_i^2 g_i \,.\, \Sigma g_i}{(\Sigma M_i g_i)^2}$, where n_i is the number, and g_i the weight of the molecular species M_i, are easily recognized as cases of the Cauchy inequality[1] $(\sum_1^n a_i b_i)^2 \leqslant \sum_1^n a_i^2 \sum_1^n b_i^2$, with $a_i = M_i n_i^{1/2}$, $b_i = n_i^{1/2}$, for the number and distribution, and $a_i = M_i g_i^{1/2}$, $b_i = g_i^{1/2}$ for the weight distribution. In its integral form, this inequality is often referred to as the Schwarz inequality[2].

The relation between these inequalities and the standard deviation of either the number or the weight distribution of molecular weights has been given for the general case in a previous communication[3].

(2) The higher terms in the expression for Hc/τ according to Debye's formula for the dependence of the molecular weight of a polymer upon the turbidity of the polymer in solution[4,5] contain quantities of the structure $\frac{\Sigma M_i^2 \gamma_i}{(\Sigma M_i \gamma_i)^2}$ and $\frac{\Sigma M_i^3 i}{(\Sigma M_i \gamma_i)^3}$ where $\gamma_i = \frac{g_i}{\Sigma g_i}$. Writing them as

$$\frac{\Sigma M_i^2 \gamma_i}{(\Sigma M_i \gamma_i)^2} = \frac{\Sigma M_i^2 g_i \,(\Sigma g_i)^2}{(\Sigma M_i g_i)^2 \,\Sigma g_i} = \frac{\Sigma M_i^2 g_i \,.\, \Sigma g_i}{(\Sigma M_i g_i)^2}$$

and

$$\frac{\Sigma M_i^3 \gamma_i}{(\Sigma M_i \gamma_i)^3} = \frac{\Sigma M_i^3 g_i \,(\Sigma g_i)^3}{(\Sigma M_i g_i)^3 \,\Sigma g_i} = \frac{\Sigma M_i^3 g_i \,.\, (\Sigma g_i)^3}{(\Sigma M_i g_i)^3},$$

the first is recognized as a special case of the Cauchy inequality, and the second as a case of the more general Hölder inequality[6]:

$$\sum_1^n a_i b_i \;<\; (\sum_1^n a_i{}^r)^{1/r} \,.\, (\sum_1^n b_i{}^{r'})^{1/r'},$$

for $r > 1$, and $1/r + 1/r' = 1$ with $a_i = M_i g_i^{1/r}$, $b_i = g_i^{1/r'}$, $r = 3$, $r' = 3/2$.

This applies similarly to the higher terms in the expression for Hc/τ.

The relation between this inequality for $r > 2$, and the standard deviation σ of the weight distribution of molecular weights, is given by[7]

$$\frac{\Sigma M^r{}_i \gamma_i}{(\Sigma M_i \gamma_i)^r} \geqslant (1 + \sigma^2/M_w{}^2)^{r-1}.$$

Writing M_{w_r} for the rth moment of the weight distribution $\Sigma M_i{}^r{}_{,i}$, the inequality can be expressed as

$$\sigma^2 \leqslant \frac{M_{w_r}{}^{1/r-1}}{M_{w_1}{}^{r/r-1}} \, M_{w_1}{}^2 - M_{w_1}{}^2,$$

$$\text{or} \quad \sigma^2 \leqslant M_{w_r}{}^{1/r-1} \, M_{w_1}{}^{\frac{r-2}{r-1}} - M_{w_1}{}^2.$$

This is the generalization of the expression for the equality $\sigma^2 = M_z M_w - M_w{}^2$, given in ref. 3.

(3) In Svedberg's formula for the molecular weight by the ultracentrifuge sedimentation method[8],

$$M_i = \text{const.}\; s_i/D_i.$$

M_i appears as a function of the sedimentation and diffusion constants. Since s_i and D_i differ from one molecular weight species to the other, and since the molecular weight of a polymer is an average molecular weight, the most obvious way for calculating $\overline{M}$ would be to average all the ratios s_i/D_i, that is, to form either their number, weight or z-average, and take $\overline{M}$ as being proportional to one of these averages.

But the actual procedure is different; the averages $\bar{s}$ and $\overline{D}$ are substituted in the formula, and the average molecular weight $\overline{M}$ is calculated, not as being proportional to the average ratio $\overline{s/D}$, but to the ratio of the two averages $\bar{s}$ and $\overline{D}$. Remembering now that s_i and D_i themselves may be averaged in different ways, yielding either the number, weight or z-average, to name only these three types, and may thus enter the formula as s_n, s_w, s_z and D_n, D_w, D_z, it is clear that $\overline{M}$ will be neither a pure number, weight, nor z-average, but will be proportional to the ratio of any two of such averages. As symbol for this type of average, we use M_{kl}, where $k = n,w,z \ldots$; $l = n,w,z \ldots$. Thus, if the ratio of averages is s_w/D_w, the molecular weight average will be denoted by $M_{w,w}$.

The averages M_{kl} will, as a rule, not be equal to M_k, the difference being the greater the greater the diversity of the molecular weights. This inequality thus stands again in a relation to the dispersion of molecular species in the polymer, which can be expressed as follows[9]:

$$|\overline{s/D} - \bar{s}/\overline{D}| \leqslant \frac{K\sigma_D{}^2 + \sigma_s\sigma_D}{\overline{D}^2},$$

where K is the maximum ratio s_i/D_i, and σ_s,σ_D the standard deviations of s and D respectively.

In order to show the dependence of the inequality upon the properties of the distribution of s and D more clearly, we write v_D for $\sigma_D/\overline{D}$, and the right-hand side becomes

$$\frac{K\sigma_D{}^2 + \sigma_s\sigma_D}{\overline{D}^2} = Kv_D{}^2 + \frac{\sigma_s}{\overline{D}} v_D = v_D{}^2 \left(K + \frac{\sigma_s}{\sigma_D}\right)$$

and $\dfrac{|\overline{s/D} - s/\overline{D}|}{v_D{}^2} - K \leqslant \dfrac{\sigma_s}{\sigma_D}$.

Substituting now for $\bar{s}/\bar{D}$ the symbol M_k/C, and for $\bar{s}/\bar{D}$ the symbol M_{kl}/C, where C is a constant, we have

$$\frac{|M_k - M_{kl}|}{C \cdot v_D^2} - K \leqslant \frac{\sigma_s}{\sigma_D},$$

from which we see that on the basis of the inequality between M_k and M_{kl}, conclusions can be drawn as to the ratio between the two standard deviations σ_s and σ_D. This gives the general structure of the relation which Jullander[10] has treated on the assumption of the log normal law governing the distribution of both s and D.

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March 2.

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Determination of Chemical Purity

In developing the isotope dilution method of amino-acid analysis, we have been concerned with the difficulty of proving the purity of the isolated sample of amino-acid, upon which the accuracy of the determination depends. Elementary analysis and the estimation of reactive groups are not always entirely satisfactory, because the contaminants most likely to be present in such purified material are those which have a very similar composition. Shemin[1] has reported the contamination of glutamic acid hydrochloride by cystine dihydrochloride even after repeated crystallization, and Keston, Udenfriend and Cannan[2] have emphasized the danger of co-precipitation of nearly related amino-acids and their derivatives.

The fact that the solubility of a pure substance is independent of the amount of excess solute has been used as a criterion of the homogeneity of proteins[3] and of amino-acids[4]. In these and other cases conventional methods were used for the determination of solubility. We have found that for substances of relatively low molecular weight a sensitive measure of purity can conveniently be obtained by comparing the vapour pressures of two solutions, one containing a slight excess of solid and the other a large excess. In this way small amounts of impurity, of the order of 1 per cent or less, can be detected in amino-acids.

The apparatus used is a simple differential tensimeter, with xylene as the manometer liquid; water has normally been the solvent. Under the conditions indicated in the table, a recrystallized sample of L-glutamic acid hydrochloride contained sufficient impurity to show a difference in vapour pressure of 6 mm. Synthetic mixtures with known amounts of L-aspartic acid hydrochloride gave proportionately increased differences in pressure, approximately 5 mm. for each 0·1 per cent of added impurity. It is concluded therefore that the original sample of L-glutamic acid hydrochloride contained less than 0·2 per cent L-aspartic acid hydrochloride. Using synthetic mixtures of L-glutamic acid hydrochloride and its enantiomorph, it was found possible to detect the presence of *c.* 0·2 per cent of the D-form, and there may well be occasions on which this method proves convenient for the determination of optical purity.

Purification of 'Analar' glycine yielded a product which (under the conditions indicated in the table) showed a pressure difference of 17 mm. Addition of known weights of DL-alanine to this material again gave proportionately increased differences in pressure (approximately 3 mm. for each 0·1 per cent alanine) and the presence of 0·3 per cent alanine in glycine can readily be detected. If required, it should, of course, be possible to increase the sensitivity considerably.

The simple nature of this method may make it useful as a routine test for the purity of other substances for which more usual tests, such as melting-point determination, are unsatisfactory. Such results as those shown in the table for 'Analar' samples of potassium chloride, sulphanilic acid and phenol suggest that only relatively small amounts of low-molecular weight impurities can be present. This procedure should be especially useful for substances which fail to crystallize.

Substance	Pressure difference (mm. xylene)
1. L-Glutamic acid hydrochloride	6
2. Recrystallized glycine	17
3. 'Analar' potassium chloride	*c.* 1
4. 'Analar' phenol	6
5. 'Analar' sulphanilic acid	16
6. Sulphanilic acid compared with a mixture of sulphanilic and metanilic acids	75

In experiments 1–5, vessel I contained *c.* 0·1 gm. substance and 0·1 c.c. water; vessel II contained *c.* 1·0 gm. substance and 0·1 c.c. water. The temperature of the bath was 54°.

Proof of identity, comparable with that of 'mixed melting points', may be obtained in analogous fashion; solutions saturated on one hand with sulphanilic acid alone, and on the other hand with both sulphanilic and metanilic acids, gave a large difference in pressure.

It must be borne in mind that there are certain limitations (which have been discussed elsewhere[3]) inherent in the use of the 'solubility criterion' of purity. If, however, care is taken to examine solutions with a minimum excess of solid as well as those containing a large excess, and if observations are made with more than one solvent, then strong evidence of homogeneity may be obtained.

We are grateful to the Department of Scientific and Industrial Research for a grant for a special research which has made this work possible, and to the Government Grants Committee of the Royal Society for financial assistance.

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June 28.

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FORTHCOMING EVENTS

Monday, September 19—Thursday, September 22

SOCIETY FOR APPLIED BACTERIOLOGY (at University College of Wales, Aberystwyth).—Summer Conference.

Tuesday, September 20

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. J. G. W. Davies: "Current Studies in Human Relations in American Industry".

Thursday, September 22

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at London School of Hygiene and Tropical Medicine, Gower Street, London, W.C.1), at 6.30 p.m.—Annual General Meeting, to be followed by an address by Mr. C. O. Stanley.

Thursday, September 22—Friday, September 23

BRITISH IRON AND STEEL RESEARCH ASSOCIATION, STEEL CASTINGS DIVISION (at Ashorne Hill, Leamington Spa).—Conference on "Foundry Steel Melting".

Thursday, September 22—Saturday, September 24

FARADAY SOCIETY (in the Department of Chemistry, The University, Reading).—General Discussion on "Chromatographic Analysis".

SOCIETY OF DYERS AND COLOURISTS (in the Lounge Hall, Harrowgate).—Symposium on Photochemistry in Relation to Textiles.

Friday, September 23

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, School of Medicine, Leeds), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ADVISORY OFFICER IN HORTICULTURE (Grade III) and an ASSISTANT ADVISORY OFFICER IN HORTICULTURE (Grade A)—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (September 24).

ASSISTANT LECTURER IN CHEMISTRY and an ASSISTANT LECTURER or LECTURER IN THE DEPARTMENT OF AGRICULTURAL BOTANY—The Secretary and Registrar, University College of North Wales, Bangor (September 24).

UNIVERSITY LECTURER IN MATHEMATICS, preferably with special qualifications in fluid dynamics—Dr. A. J. Ward, Emmanuel College, Cambridge (September 26).

CHEMIST at Kempton Park, Middlesex, to carry out experimental work with full-scale plant on the purification of river-derived waters—The Clerk of the Board, Offices of the Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1 (September 30).

UNIVERSITY LECTURER or a UNIVERSITY DEMONSTRATOR IN PHYSICS—The Secretary of the Appointments Committee, University Chemical Laboratory, Pembroke Street, Cambridge (September 30).

LECTURER IN THE DEPARTMENT OF PHARMACOLOGY of the School of Pharmacy—Professor of Pharmacology, 17 Bloomsbury Square, London, W.C.1 (October 1).

ASSISTANT LECTURER IN BIOCHEMISTRY in the Department of Physiology—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (October 3).

LECTURER (Grade I) IN MECHANICAL ENGINEERING and a LECTURER (Grade II) IN MECHANICAL ENGINEERING—The Director, Robert Gordon's Technical College, Aberdeen (October 5).

RESEARCH OFFICER FOR CHEMICAL ENGINEERING SECTION, Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organisation, at Fishermen's Bend, Melbourne, to conduct research into the fluid bed gasification of low rank coals—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 2398 (October 8).

PROFESSOR OF AERONAUTICAL ENGINEERING at the Faculty of Engineering, Fouad I University, Giza, Egypt—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, Park Lane, London, W.1 (October 22).

LECTURER IN PHYSICAL EDUCATION at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 7).

ASSISTANT CONSERVATOR OF FORESTS, Ministry of Agriculture, for service in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, marking envelope "Assistant Conservator".

BIOCHEMIST (Non-Medical) (duties would primarily lie in the application of microchemical methods to the diagnosis and treatment of children's diseases)—The Superintendent, The Children's Hospital, Western Bank, Sheffield 10.

BIOPHYSICIST—The Deputy Director, Wilkie Surgical Research Laboratory, University, Edinburgh.

FIELD ASSISTANTS (Research) required by East Africa High Commission for the Desert Locust Survey—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/22933/3F on letter and envelope.

HEAD OF THE DEPARTMENT OF PHARMACY AND PHYSIOLOGY (should be qualified to teach one or more of the subjects Physiology, Pharmacology and Bacteriology)—The Registrar, Municipal College, Portsmouth.

LECTURERS (part-time) IN BOTANY or ZOOLOGY or BIOLOGY to intermediate science or general degree standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

LECTURER IN ELECTRICAL ENGINEERING in the Ministry of Supply School of Electronics, Malvern—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs.

MECHANIC FOR THE PHYSICS DEPARTMENT WORKSHOP—The Secretary and House Governor, Mount Vernon Hospital and Radium Institute, Northwood, Middx.

MEDICAL LABORATORY TECHNICIAN for the Haematology and Clinical Pathology Department—The Secretary, County Hospital, Lincoln.

PROFESSOR OF AGRICULTURAL CHEMISTRY at the School of Agriculture—The Registrar, The University, Nottingham.

RESEARCH ASSISTANT (with a good honours degree in Physics) in THE DEPARTMENT OF MINING AND FUELS—The Registrar, The University, Nottingham.

RESEARCH STUDENTSHIP IN THE DEPARTMENT OF FORESTRY for the study of Morphological and Silvicultural variations in coniferous species (applicants should have a good honours degree in Botany or be graduates in Forestry with research experience)—The Secretary of the University, Marischal College, Aberdeen.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Institute of Management. Conference Series 9: Indices of Productivity. Pp. 36. (London: British Institute of Management, 1949.) 2s. 6d. [48

Service for Management. Pp. 12. (London: British Institute of Management, 1949.) [48

Occasional Papers on Eugenics. No. 5: Population Trends and the World's Biological Resources. By Dr. G. C. L. Bertram. Pp. 36. (London: Eugenics Society, and Cassell and Co., Ltd., 1949.) 2s. net. [48

Some Notes on Galen's Anatomy. By Dr. W. L. H. Duckworth. (Linacre Lecture, 6 May, 1948.) Pp. 42. (Cambridge: W. Heffer and Sons, Ltd., 1949.) 2s. 6d. net. [48

Aslib Guides to Sources of Information in Great Britain. No. 3: Beverages and Food. Pp. iii+56. (London: Aslib, 1949.) 12s. 6d. net; to Aslib Members, 10s. [48

Percy Faraday Frankland. (First P. F. Frankland Memorial Lecture.) By Dr. Leslie H. Lampitt. Pp. 14. 3s. net. Anaesthetics. By Prof. H. B. Nisbet. Pp. 30. 3s. net. Report of a Conference on the Origins and Prevention of Laboratory Accidents, 6 November, 1948. Pp. 80. 5s. 6d. net. (London: Royal Institute of Chemistry, 1949.) [48

Ministry of Civil Aviation. ORS/MCA Report No. 7: Experiments in Clearing Birds from Airfields. By F. R. Adams. Pp. 25. (London: Ministry of Civil Aviation, 1949.) [48

The Science of Relationships. 3: Report of a Conference on Rural Life at Home and Overseas held at High Leigh, Hoddesdon, Herts., January 11–14, 1949. Pp. 64. (London: Church Missionary Society, 1949.) 2s. [48

Other Countries

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 114, Nr. 2: On the Pre-Permian Basement of the Giesecke Mountains (Gauss Peninsula), Northern East Greenland. By Dr. Wolf Mayne. Pp. 65. 4 kr. Bd. 133, Nr. 3: The Cretaceous Beds between Kuhn Island and Cape Franklin (Gauss Peninsula), Northern East Greenland. By Dr. Wolf Mayne. Pp. 292+4 plates. 22 kr. Bd. 139: On the Placodermi of the Upper Devonian of East Greenland, 2. By Erik A:son Stensiö. Pp. 622+75 plates. 55 kr. Bd. 142, Nr. 3: The East Greenland Eskimo Dentition; Numerical Variations and Anatomy, a Contribution to Comparative Ethnic Odontography. By P. O. Pedersen. Pp. 244+30 plates. 20 kr. Bd. 144, Nr. 7: Geological Tests of the Hypothesis of Continental Drift in the Arctic Regions—Scientific Planning. By C. E. Wegmann. Pp. 48+2 plates. 3 kr. (København: C. A. Reitzels Forlag, 1948–1949.) [48

Report on the Administration of the Meteorological Department of the Government of India in 1946–1947. Pp. ii+61+10 plates. Report on the Administration of the Meteorological Department of the Government of India in 1947–1948. Pp. ii+60+12 plates. (Simla: Government of India Press, 1949.) [48

Annals of the New York Academy of Sciences. Vol. 51, Art. 3: Ocean Surface Waves. By B. Haurwitz, A. J. Abdullah, R. S. Arthur, C. C. Bates, G. E. R. Deacon, M. Ewing, J. D. Isaacs, F. John, J. B. Keller, A. A. Klebba, M. A. Mason, W. H. Munk, C. L. Pekeris, F. Press, T. Saville, Jr., H. R. Sewell, J. J. Stoker, Jr., and P. D. Thompson. Pp. 343–572. (New York: New York Academy of Sciences, 1949.) 3 dollars. [48

Catalogues

Siemens Engineering Bulletin. No. 240–1: Short Circuit Data—Short Circuit Currents in Cables. By E. A. Beavis and K. J. Hacke. Pp. 8. No. 242–3: Electric Telegraphs for Ships. By H. J. Hadlow. Pp. 4. (London: Siemens Brothers and Co., Ltd., 1949.)

Murex Review. Vol. 1, No. 4. Pp. 65–76. (Rainham: Murex, Ltd., 1949.)

Plessey Electron Microscope. Pp. 16. (Ilford: The Plessey Co., Ltd., 1949.)

Super-Responsive 'Inkwell' Graphic Instruments. (Ref. 302/4906.) Pp. 2. (London: Everett Edgcumbe and Co., Ltd., 1949.)